1994

Integration of warranties into an aircraft engine acquisition strategy

Caldwell, Kent G.

Monterey, California. Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

INTEGRATION OF WARRANTIES
INTO AN
AIRCRAFT ENGINE ACQUISITION
STRATEGY

by

Kent G. Caldwell

June, 1994

Thesis Advisor: Alan W. McMasters

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE June 1994	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE INTEGRATION OF WARRANTIES INTO AN AIRCRAFT ENGINE ACQUISITION STRATEGY	5. FUNDING NUMBERS
6. AUTHOR(S) Kent G. Caldwell	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) NAVAL AIR SYSTEMS COMMAND CODE AIR-536 ARLINGTON, VA	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE *A

13. ABSTRACT *(maximum 200 words)*

Within the Department of Defense there continues to be considerable confusion and debate over the effectiveness of the warranty clauses required on major weapon system production contracts. Despite the fact that they have been mandated by law since 1985, and that their costs are estimated at over two percent of total hardware costs, a uniform process to ensure their proper development and administration does not exist. Because of the politics involved, Program Managers have received considerable direction in the form of "thou shalt", but virtually no guidance as far as "how to". Fortunately, significant efforts have been made by individual programs to correct problems experienced in the past and execute warranties that make sense. Their focus, however, has been on improving warranty administration. In contrast, this thesis looks at the warranty development process and discusses the potential improvements from the early integration of the warranty development into an aircraft engine's acquisition strategy. The findings of this report support avoiding insurance warranties, changing the Navy's "no-cost" warranty policy, and including warranty reviews as part of the Milestone review process. There is potential for significant reductions in life cycle costs from this approach and universal applicability across all platforms and services.

14. SUBJECT TERMS Aircraft Engine Warranty, Weapon System Warranty, Acquisition Strategy.			15. NUMBER OF PAGES 217 16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)

Prescribed by ANSI Std. 239-18

Approved for public release; distribution is unlimited.

Integration of Warranties
into an
Aircraft Engine Acquisition Strategy

by

Kent G. Caldwell
Lieutenant Commander, United States Navy
B.S., State University of New York, Brockport, 1979

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1994

Author: [redacted]
Kent G. Caldwell

Approved by: [redacted]
Alan W. McMasters, Principal Advisor

[redacted]
David R. Henderson, Associate Advisor

[redacted]
David R. Whipple, Chairman
Department of Systems Management

ABSTRACT

Within the Department of Defense there continues to be considerable confusion and debate over the effectiveness of the warranty clauses required on major weapon system production contracts. Despite the fact that they have been mandated by law since 1985, and that their costs are estimated at over two percent of total hardware costs, a uniform process to ensure their proper development and administration does not exist. Because of the politics involved, Program Managers have received considerable direction in the form of "thou shalt", but virtually no guidance as far as "how to". Fortunately, significant efforts have been made by individual programs to correct problems experienced in the past and execute warranties that make sense. Their focus, however, has been on improving warranty administration. In contrast, this thesis looks at the warranty development process and discusses the potential improvements from the early integration of the warranty development into an aircraft engine's acquisition strategy. The findings of this report support avoiding insurance warranties, changing the Navy's "no-cost" warranty policy, and including warranty reviews as part of the Milestone review process. There is potential for significant reductions in life cycle costs from this approach and universal applicability across all platforms and services.

TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND

Beginning in 1984, as part of the Defense Appropriations Act, congressional action was taken to make warranties mandatory on all production contracts for major weapon systems (Appendix A). Further refinements in 1985 resulted in Title 10, Section 2403 of the United States Code (10 U.S.C. 2403) (Appendix B). Since that time, the Department of Defense (DoD) has been required to obtain warranties for weapon systems over specified dollar thresholds unless waived by the Secretary of Defense. In addition, the DoD has promulgated implementing directives and diligently reviewed all weapon system procurement contracts to ensure compliance. However, the DoD has been highly criticized in external reviews by various agencies, including the General Accounting Office (GAO) [Ref. 2 and 3], for the poor administration of these warranties. Additionally, they have documented the limited success in obtaining redress for breaches in warranty. It is generally believed that the DoD is paying too much for warranties and getting too little and that contractors are taking our warranty payments to the bank in the form of additional profit (Balaban, 1985).

The majority of the work done to date to improve weapon

system warranties has been in the area of improved administration through changes in contractual language. This is particularly true for aircraft engine warranties. The Joint Aeronautical Commanders Board sponsored a joint service working group to develop a common aircraft engine warranty. Although still in development, a copy of its latest revision effort is included as Appendix C. There has been relatively little emphasis on integrating the development of the weapon system warranty and the warranty administration plan with the acquisition strategy.

Although not a major weapon system, aircraft engines fall under the same requirements for warranties because the Defense Federal Acquisition Regulation Supplement (DFARS) expands the warranty requirement to sub-systems over certain dollar thresholds. They do provide an excellent opportunity to evaluate the economic and logistic impact of alternative warranty approaches used in production contracts. This is of particular interest to AIR-536 because, in its role as the engine program manager for NAVAIR, they must consider the relationship between warranties and Life Cycle Costs as well as the impact on the Component Improvement Program (CIP). The CIP addresses emerging engineering and logistic problems on mature aircraft engine systems. A truer understanding of the trade-offs between warranties and CIP would enable better resource allocation.

It must be recognized that aircraft engine development and

procurement are different from that of major weapon systems. Engines are an integral part of the host aircraft acquisition plan and, as such, are funded through the aircraft PMA. Because they represent only a segment of the total procurement package being managed by the aircraft Program Manager for Acquisition (PMA), there is not a stand-alone PMA for engines. AIR-536 is dual-hated in its role as the engineering class desk for engines and as the acting engine PMA for the aircraft PMA's.

In a previous thesis, entitled "Analysis of Navy Aircraft Engine and Component Warranties," LCDR Melissa S. Andrews and CPT Suzanne Hickey investigated the problems associated with the administration of aircraft engine warranties in the Navy. (Andrews, 1994) It drew comparisons with a major commercial airline engine warranty program and made recommendations regarding potential improvements in warranty administration. Their historical research laid the ground work for this study.

B. OBJECTIVES

The primary objective of this study is to determine if there is a better way than currently exists to develop aircraft engine warranties that would meet the federally required warranty clauses, including those covering essential performance requirements (EPRs). The focus is on exploring the potential advantages of integrating the engine's warranty development and the warranty administration plan into the

acquisition strategy.

The goal is to develop a common sense approach to warranties that would maximize effectiveness by minimizing the risk and therefore cost. This approach would be useful for evaluating alternative warranty concepts and their effect on the engine Life Cycle Costs (LCC) and the Component Improvement Program (CIP). It is hoped that this study will serve as a useful guide for the aircraft engine program managers and their support staff.

C. RESEARCH QUESTIONS

The primary research question was:

1. How can the Navy integrate required warranty clauses, including essential performance requirements (EPRs) into the aircraft engine acquisition strategy to maximize effectiveness and reduce risk?

The subsidiary research questions were:

1. Are weapon system warranties cost-effective?
2. How does the Navy estimate warranty costs and benefits?
3. What are the logistic and Life Cycle Cost impacts associated with the different types of warranties?
4. What is the impact of the current political initiatives on warranty policy and program management?

D. SCOPE

The original scope of this thesis was limited to the performance of a series of post-award Life Cycle Cost (LCC)

analyses on previously executed aircraft engine production contracts in order to determine, if possible, the optimal employment of required warranty clauses for a particular aircraft engine acquisition strategy.

It was hoped that a detailed cost analysis would be possible, despite the Navy's policy on obtaining "no-cost" warranties. Unfortunately, the difficulties encountered in determining actual warranty costs precluded that endeavor. The analysis focusses instead on the economic effects of integrating the aircraft engine warranty development and administration into the acquisition strategy. It also looks at the compatibility of the specific warranties required by federal law with the function they are intended to perform; that is, to produce higher quality weapon systems with minimum life cycle costs.

Due to the political nature of this topic, it was necessary to include a review of the current DoD and legislative action associated with weapon system warranties. It was also necessary to assess the strengths and weaknesses of the current military directives, procurement review procedures, and the training programs for acquisition professionals as well.

The study took advantage of recent contract negotiations on the Rolls-Royce F405-RR-402 engine used in the T-45A aircraft and the F402-RR-408 being used in the AV-8B Harrier. It also looked at the historical problems associated with the

General Electric F404-GE-400 used in the F/A-18A/B & C/D and the F110-GE-100, which is an Air Force managed engine being used in the Navy F-14D. With this historical background, the analysis focused on the warranty approaches being considered for the General Electric F414-GE-400 engine being developed for use in the F/A-18 E/F.

The results of the economic analysis were then used to develop a set of guidelines to evaluate the effectiveness of alternative warranty approaches for aircraft engines based on the acquisition strategy. The findings of the economic analysis, in conjunction with the policy analysis and program management assessment, were used to support recommended changes to the management, development and use of warranties in the DoD.

E. RESEARCH METHODOLOGY

The data to support this thesis was collected from a number of different sources. Following a comprehensive literature review, additional information was obtained through telephone interviews with program managers, and applicable staff personnel at all levels within the DoN and the DoD.

Personal on-site interviews were conducted with representatives from the Office of the Secretary of Defense (OSD), Assistant Secretary of the Navy (ASN), Naval Air Systems Command (NAVAIR), and industry specialists. Additional technical data support was provided by the research sponsor,

AIR-536, and the logistic support staff in AIR-410.

Post-award warranty effectiveness analysis reviews were conducted on several major aircraft engine production contracts. Some of the engines reviewed had contracts issued both before and after the implementation of the law. This assisted in the determination of the relative strengths and weaknesses of different warranties based on their compatibility and degree of integration with the engine acquisition strategy.

It must be acknowledged that the theoretical economic analysis portion of this study was strongly supported by two major works on weapon system warranties. The first, Warranty Handbook, was written in 1986 by Harold S. Balaban of AIRINC for the Defense Systems Management College. The second was written in 1987 by the Institute for Defense Analysis (IDA Paper P-2024) for the Office of the Secretary of Defense, Program Analysis and Evaluation (Kuenne, 1987). Its thorough and detailed academic reviews of the economic theory of warranties and their role in weapon system procurement are the cornerstone of this study.

The level of assistance obtained on the policy analysis and program management assessment aspects of the study from all who participated was invaluable. The enthusiastic support received from the faculty at the Naval Postgraduate School, program managers within the DoD and industry experts in the conformation of principles used in this study was truly

appreciated.

F. ORGANIZATION OF STUDY

Chapter II., BACKGROUND, presents a chronological review of significant issues and events which have shaped the state of weapon system warranties. The review covers the politics and congressional action surrounding warranties, including those affecting weapon system program management and acquisition reform. Next, a brief presentation of the applicable directives and the history of related policy decisions within the DoD and DoN are given. The chapter concludes with a discussion on the Navy's aircraft engine program management and the Component Improvement Program (CIP).

Chapter III., ECONOMIC PRINCIPLES OF WARRANTIES, reviews pertinent literature and explains the economic theory of warranties in the public sector, warranty types, and their applicability. Additionally, it covers the determination of warranty costs and the concept of the "no-cost" warranty. The chapter concludes with a discussion of the impact of warranties on Life Cycle Cost (LCC) and the Component Improvement Program (CIP).

Chapter IV., ANALYSIS, presents the findings of the research in detail, objectively and without bias. The chapter is divided into three sections which cover an economic analysis of the required warranty clauses found in both the

Section 2403 and the direction provided in both the FAR and DFARS, the findings of the analysis conducted on the current warranty policy at all levels within the DoD and a Warranty Program management assessment. Chapter V., AIRCRAFT ENGINE WARRANTY ANALYSES, continues the analysis portion of the thesis as it presents the effectiveness of actual warranties applied to the engine systems reviewed. It ties the theoretical to the observed, and identifies significant trends. Chapter VI., ENGINE WARRANTY INTEGRATION GUIDELINES, concludes the analysis portion of the thesis with a set of a guidelines which were developed to assist program mangers in the future development of effective and efficient aircraft engine warranties that are integrated into the engine and aircraft acquisition strategy.

Chapter VII., SUMMARY, CONCLUSIONS AND RECOMMENDATIONS, summarizes the findings, analysis and the conclusions. There are several strong recommendations for institutionalizing changes necessary to rectify the current shortfalls in the program. Additionally, areas that warrant further research are presented and discussed.

II. BACKGROUND

This chapter presents a chronological review, beginning in 1964, of the significant issues and events that have shaped the development and use of weapon system warranties. The review covers the political and congressional action surrounding warranties and the law, as well as the associated DoD and DON directives and policy guidance. It also introduces the concept of acquisition strategy as it applies to weapon system program management and warranties. The chapter concludes with a discussion of the Navy's management of aircraft engines and the engine Component Improvement Program (CIP).

The history of weapon system warranties in the DoD can be separated into two major periods. The first, which began in 1964, is referred to as the pre-mandated period. Discussed in the next section, this period came to an end in 1984, when the requirement for warranties on weapon system procurement contracts became mandated by federal law.

A. WARRANTY DEVELOPMENT IN THE PRE-MANDATED ERA

The best place to start is at the beginning. Independent of ongoing action within the DoD at this time, the origin of warranties was the evolution of common law, from which the Uniform Commercial Code (UCC) developed. Codified in the

Defense Acquisition Regulations (DAR) in 1978, the UCC provides all buyers of goods in normal commercial transactions with two implied warranties:

1. *Merchantability,* or the assurance that the goods will pass in trade as described and that they are fit for the ordinary purposes for which such goods are used.

2. *Fitness for a particular purpose,* or the additional guarantee that the goods are fit for the particular purpose for which the buyer will use them when a) the seller has reason to know of such purpose and b) the buyer is relying on the seller's expertise and judgment in their selection and provision.

It is important to understand that these implied warranties are significant in that they apply to the hardware bought by the DoD as well. It is ironic to note that it is the use of the standard inspection clause used in virtually all DoD contracts and any explicit warranty clause that nullifies the protection provided by these implied warranties. It is the extension of the government's right to inspect and accept goods delivered as well as the protection offered by explicit warranty clauses that voids the implicit protection under common law.

The origin of common weapon system warranties used in the DoD dates back to 1964 when Secretary of Defense Robert McNamara began an initiative to unify warranty practices among the services. As a result of his initiative, the Armed Services Procurement Regulations (ASPRs) were updated in 1967 to include a set of guidelines for contracting officers. These guidelines were developed to assist them in determining if a

warranty would be in the best interest of the DoD for a specific procurement. According to the Warranty Handbook, (Balaban, 1986) the guidelines made the use of long-term warranties on weapon system acquisitions the exception rather than the rule.

A resurgence of interest in warranties surfaced in the mid-70's when the DoD began the development and use of the Reliability Improvement Warranty (RIW). Used primarily in the acquisition of electronic subsystems, the RIW generally provided for the repair of the defective component over some period of time for a fixed price. They were described in the IDA paper as "an experiment in the use of warranties for positive and negative incentivization." The term RIW was later used to describe a wide range of warranties. These warranties continued to feature both positive and negative incentives for the expressed purpose of improving the reliability, maintainability, and availability of the purchased equipment.

These warranties documented the government's first significant attempt to affect control of equipment performance in the post-acceptance period. It was this effort and the growing concern over the poor performance of several weapon systems that has been credited with motivating Congress to mandate warranties.

B. POLITICS, THE LAW, AND CONGRESSIONALLY MANDATED WARRANTIES

1. Section 794

The Congressional action taken in the early 1980's to mandate warranties was an attempt to reduce the cost of rectifying the problems in performance and reliability of systems like the M1 tank and the Bradley Fighting Vehicle recently delivered to the DoD. What began in 1983, and was finalized with the passage of the Section 794 of the Defense Appropriations Act of 1984 (Appendix A), marked the beginning of the era of mandated weapon system warranties in the DoD. The new law, which required the use of warranties on all weapon systems contracts after its enactment, placed emphasis on obtaining guaranteed performance of specific operational characteristics of the system. Its wording appeared to extend indefinitely the period of contractor liability after acceptance.

The controversy over the wording and expected impact of this landmark piece of legislation led Deputy Secretary of Defense Thayer to issue a blanket waiver of the requirements until implementing instructions could be developed. The high level of concern and the issues raised by both the DoD and industry fueled the debate with Congress and eventually led to the replacement of Section 794 the following year.

2. Section 2403

The revised warranty requirements were signed into law as part of the Defense Procurement Reform Act of 1984. The section concerning warranties later became Title 10 of the United States Code, Section 2403 (Appendix B). Since 1 January, 1985, the DoD has been required to obtain warranties for all weapon systems production contracts over specified dollar thresholds unless a waiver is obtained.

Specifically, the act requires the DoD to obtain a written guarantee from the prime contractor that each item delivered will conform to the design and manufacturing requirements delineated in the production contract; be derived free from all defects in materials and workmanship; and conform to the essential performance requirements (EPRs) specifically delineated in the production contract. Additionally, the act requires the contractor to take prompt action to correct any failure to meet the guarantee, at no additional cost, or pay any costs reasonably incurred by the government to do so.

It allows the Secretary of Defense to waive any or all of the required clauses if it is determined to be necessary in the interest of national defense, or that a guarantee would not be cost-effective. In either case, the Secretary of Defense is required to notify the Committees on Armed Services and on Appropriations of both the Senate and the House of Representatives in writing of any intent to waive any or all

of the requirements.

3. The DoD Responds

During the period that immediately followed the legislative action, the Federal Acquisition Regulation (FAR), and the Defense Federal Acquisition Supplement (DFARS) were updated to include the Section 2403 requirements. Likewise, all applicable military implementing directives were updated and policy guidance memorandums were generated to show their support for the new warranty program. The effects of the minor changes made to the program by these directives will be addressed in the next section.

This period was also marked by a substantial amount of program review and analysis. The efforts sponsored by the DoD, like the "Warranty Guidebook" (Balaban, 1986) and the IDA Paper, "Warranties in Weapon System Procurement: An Analysis of Practice and Theory", (Kuenne, 1987) were substantive works that attempted to take the warranty debate out of the political arena. They presented a logical discussion of the issues concerning weapon system warranties. Additionally, they made recommendations regarding warranty implementation based on sound economic theory.

4. Weapon System Warranties in Practice

The published findings from audits and program reviews conducted on the DOD's management of the warranty program to date are not flattering. The general consensus appears to be

that the DoD is not doing an effective job of administering weapon system warranties. As a result, the DoD has continued to receive a good deal of negative visibility "on the Hill" over this issue. Despite all the bad press, the DoD has continued to push for a repeal of Section 2403 requiring the mandatory use of weapon system warranties.

In 1992 the Director for Defense Procurement, Ms. Eleanor R. Spector, from the Office of the Under Secretary of Defense (Acquisition), initiated an internal review of weapon system warranty practices in response to two GAO reports criticizing the DoD'S implementation and administration of warranties. (GAO/NSIAD-87-122 July 21, 1987 and GAO/NSIAD-89-57 September 27, 1989) The Office of the Deputy Director for Defense Systems Management Procurement Strategies published the results of the review in September, 1992 in the Report on the Administration of Department of Defense Weapon System Warranties. Based on the findings of the review Ms. Spector's staff concluded that "Deficiencies exist in the warranty administration capabilities of the services" and that "Warranty benefits are not fully realized on DoD contracts". The bottom line of the report, which was forwarded to the each of the service secretaries, was the recommendation for "A repeal of the warranty statute (10 U.S.C. 2403)."

5. Continued Congressional Concern

Since the implementation of the law, the Congress and

the DoD have continued to strive to improve the way weapon systems and all materials used by the DoD are purchased. In 1990, Congress enacted the Defense Acquisition Workforce Improvement Act (DAWIA) as part of the 1991 Defense Authorization Act. Now incorporated in Title 10 United States Code, Sections 1702-1764, DAWIA attempts to bring more centralized management and more professional development, education, training, and career opportunities to the DoD acquisition workforce.

6. The DoD Responds to Change

The need to change the way the DoD does business gained so much visibility that a new office was established within the DoD just to deal with this issue. The Office of Acquisition Reform is now responsible for sponsoring such efforts from within the DoD. One such effort was the recent Report of the Acquisition Law Advisory Panel to the United States Congress on Streamlining Defense Acquisition Laws.

Commonly referred to as the Section 800 Panel, its independent review of the current legislation in practice was published in 1993. Its comments regarding warranties echoed those provided by the Director of Defense Procurement, and recommended a repeal of Section 2403. The Office of the Assistant Secretary of the Navy and the Office of the Assistant Secretary of the Air Force both supported the recommendation. The Army did not. According to the Army

representative, it was its position that "warranties offer tangible and intangible benefits which promote product quality improvements which make costly warranty repair unnecessary".

7. Current Warranty Legislative Initiatives

The debate over the warranty issue continues today. Interestingly, there appears to be some support for a repeal from within both the Congress and the Administration. In interviews with the researcher, Mr. Mike Sipple (Sipple, 1994) and Ms. Teresa Brooks (Brooks, 1994) from the Office of the Director for Defense Procurement, indicated that the OSD was monitoring three pieces of legislation currently "on the Hill" that deal with weapon systems warranties. One of these is Representative Bilbray's Defense Acquisition Reform Act of 1993 in the House of Representatives (H.R. 3586, Section 204) which concurs with Ms. Spector's recommendation to repeal 10 U.S.C. 2403.

Support for a repeal from the administration was evident in an official letter from the Office of Management and Budget (OMB) to the Staff Director on the Senate Committee on Governmental Affairs (OMB, 1993). In the letter to Mr. Leonard Weiss dated November 5, 1993, Mr. Allan Burman, Administrator of the OMB Office of Federal Procurement Policy provides its "mark-up" of the Glenn Bill (S. 1587) which deletes the additional provisions regarding warranty guidance an substitutes "(1) Repeal. Section 2403 of Title 10, United

States Code, is repealed."

In contrast, both of the other legislative initiatives currently being tracked not only support the current language of Section 2403, but propose additional requirements as well. Using identical language, Senator Glenn's Bill (S. 1587, Sec. 2402) and an amendment that Rep. Conyer and Rep. Clinger attempted to attach to the NPR bill (H.R. 3400, Sec. 32402) add provisions that would require the Secretary of Defense to prescribe additional warranty regulations (Appendix D). These regulations would include guidelines for negotiating contracts that are reasonable and cost effective, procedures for administering contractor guarantees, and guidelines for determining when a waiver may be appropriate.

8. The DoD Divided

As recently as 10 March, 1994, Derek J. Vander Schaaf, the Deputy Inspector General for the DoD, testified before the Senate Committees on Governmental Affairs and Armed Services strongly supporting the provisions of the Glenn Bill (S. 1587). His argument in support of the proposed legislation was based on the appropriateness of warranties for commercial items.

The logic of his testimony is terribly flawed. His statement would suggest that the major weapon systems, to which this legislation applies, are commercially available. This point was discussed with the researcher at length by Mr.

Sal Guli, the Program Director of Contract Audits for the DoD Inspector General who help prepare Mr Vander Schaaf for his testimony (Guli, 1994). Mr Guli indicated that the testimony given was intended to support the use of warranties in general for all DoD procurement. Although it was not necessarily applicable to weapon systems, it supports both the continued warranty requirements established in Section 2403 and the additional provisions of the Glenn Bill requiring additional DoD warranty guidance and procedures regulations.

In summary, it is evident that mandatory weapon system warranties continue to be a sensitive political issue. In the murky world of politics the one thing that is clear, however, is that "the fight ain't over yet".

C. DIRECTIVES AND POLICY GUIDANCE

1. Directives

The primary directives governing the way in which the federal government and the DoD procure major weapon systems are the Federal Acquisition Regulation (FAR), the Defense Federal Acquisition Regulation Supplement (DFARS) and the DoD 5000 series instructions. Each one of these documents will be introduced and its relevance discussed briefly. The other directives to be discussed were issued by the Secretary of the Navy and the Naval Air Systems Command and govern the application of warranties to production aircraft engines contracts.

a. *Federal Acquisition Regulation (FAR)*

The FAR, in conjunction with the DFARS, governs all DoD procurement. Since the early 1980's, the FAR Subpart 46.7 (Warranties) has undergone extensive revisions. It provides the basic definitions and general principles of warranty use in the federal procurement. According to the latest FAR (Appendix E), "the principal purposes of a warranty in a Government contract are (1) to delineate the rights and obligations of the contractor and the Government for defective items and services and (2) to foster quality performance."

According to the section on the criteria for use of warranties, the use of warranties is not mandatory. Additionally, the FAR provides some useful guidelines and factors that contracting officers must consider when determining whether a warranty is appropriate for a specific acquisition. The factors include; the *nature and use of the supplies or services, cost,* the difficulty of *administration and enforcement,* any customary *trade practice* associated with the item, and finally consideration of *reduced requirements.*

The FAR gives the authority to include warranties to the agency or department issuing the contract. It goes on to point out that warranties should not limit the rights of the government under an inspection clause. Some of the rights include those that stem from the implied warranties of the UCC discussed earlier, such as "latent defects, fraud, or gross mistakes that amount to fraud." Other sections include

guidance on warranty terms and conditions, warranties of data and commercial items and sample contract clauses.

b. Defense Federal Acquisition Regulation Supplement (DFARS)

All the basic provisions of Section 2403, plus some additional ones, have been incorporated in DFARS Subpart 246.7--Warranties (Appendix F). The 1991 Edition, provides DoD contracting officers with the latest, up-to-date, appropriate guidance. Some of the more significant changes and important clarifications related to weapon system acquisitions and aircraft engines are listed below:

1. Subpart 246.703 allows the cost of a warranty to be included in the item's price or listed as a separate contract line item.

2. Subpart 246.770-1 defines a weapon system as "a system or subsystem used directly by the armed forces to carry out combat missions" and includes propulsion systems.

3. Subpart 246.770-2 requires that "the warranty identify redesign as a remedy" for contracts that include an EPR warranty.

4. Subpart 246.770-3 allows for the tailoring of warranty terms and conditions. It permits contracting officers to limit the contractor's financial liability if it is necessary to make it "cost effective" and to negotiate the duration of performance warranties.

5. Subpart 246.770-7 requires the performance of a cost-benefit analysis that considers both the quantitative and qualitative costs and benefits of the warranty and includes not only the costs of acquisition, administration and enforcement, but also any costs resulting from limitations in the provisions, costs incurred during development to reduce production warranty risks, and the logistical and operational benefits as well as the "additional contractor motivation" that results from the warranty.

c. Department of Defense 5000 Series Instructions

The Defense Acquisition Directive, 5000.1, dated February 23, 1991 is the lead document in a series of three instructions that canceled 63 previously issued instructions regarding the subject. Published after the Defense Procurement Reform Act of 1984, it is interesting to note that this broad reaching document, which covers the Policies Governing Defense Acquisition, does not discuss warranties. A logical place for such a discussion would be in Part 1, Section C on Acquiring Quality Products, which includes discussions on the topics of Acquisition Strategies, Program Plans and Risk Management. However, there is no mention of the word "warranty" or any reference to the requirement for them.

The DoD Instruction 5000.2, of the same date, is likewise an extensive document that establishes general policy and procedures for managing major and non-major defense acquisition programs. This instruction makes but one reference to warranties in Part 9 Section B, paragraph 3.e. This reference is with regards to the acquisition of data warranties and simply states that they will be done in accordance with the DFARS.

The DOD Instruction 5000.2M, Defense Acquisition Management Documentation and Reports, supplements the rest of the 5000 series instructions and covers the required documentation procedures and reports. This instruction also

makes no reference to warranties.

d. SECNAV INSTRUCTION 4330.17

Released on 17 September 1987 by Everett Pyatt, then the Assistant Secretary of the Navy for Logistics and Shipbuilding, this SECNAV instruction (Appendix G) merely echoed the requirements as they were established in Section 2403. This was surprising because a year earlier, Pyatt issued a policy memorandum which, although not contradictory, established the Navy's unique position on warranty costs. This memorandum will be discussed in further detail in the next section.

The instruction assigned to the Chief of Naval Operations the responsibility for administrative management of the program and the requirement to establish procedures to ensure that warranties are obtained for weapon systems meeting the cost thresholds established in Section 2403. The Comptroller of the Navy was directed to ensure procedures were in place to properly account for funds collected under the warranties.

e. NAVAIR INSTRUCTION 13070.7

The Commander, Naval Air Systems Command, published an instruction entitled "POLICY GUIDANCE FOR WARRANTY APPLICATION ON NAVAL AIR SYSTEMS COMMAND WEAPON SYSTEM PROCUREMENTS", NAVAIRINST 13070.7 on 9 December 1985 (Appendix H). It established responsibilities for the

management of the warranty program within the Systems Command along the functional lines of the organization. In addition to repeating the basic requirements as established by Section 2403, it instituted two important additional policies. The first new policy requires that all warranties have provisions requiring the contractor to furnish annual cost data on warranty repairs. The second requires that procedures be established to ensure that all acquisition plans address the planned use of warranties and their impact on user maintenance operations and logistic support systems.

2. SECNAV Policy Guidance

As a consequence of an official memorandum released by Everett Pyatt, then the Assistant Secretary of the Navy for Shipbuilding and Logistics on 8 September 1986, (Appendix I), the Navy adopted a unique position regarding warranty costs. It was Secretary Pyatt's view that the warranties required by Section 2403 should be provided to the Navy at no additional cost. He felt that the basic provisions of the warranty were nothing more than assurance that the specifications agreed to and paid for in the weapon system development and production contracts would be met. Therefore, paying for these provisions, as part of a separate warranty, would amount to paying for them twice. He did conceded in his memorandum that there may be certain circumstances in which additional costs may be appropriate and, when they are, a cost-benefit analysis

should be done.

Since that time, the Navy has basically treated all warranties as "no-cost". As a consequence, they do not appear as separate line items in production contracts. The economic theory which explains the concept of "no-cost" warranties and its impact will be explained in detail in Chapter III.

3. NAVAIR Policy Guidance

The Naval Air Systems Command, in an effort to update its policies and incorporate changes to the regulations that resulted from guidance received from multiple sources after the promulgation of the 1985 instruction, issued NAVAIR NOTICE 4855, on 17 May, 1989 (Appendix J).

In an attempt to comply with the intent of the ASN policy memorandum, the notice firmly established a NAVAIR policy in concurrence with the ASN warranty policy memorandum regarding warranty cost. According to paragraph 3. d., it is NAVAIR's policy to "Pursue a no cost warranty per reference (f)." The reference given is incorrect. Reference (g) is the ASN memorandum while reference (f) is the ASN instruction. Despite the dispute over the applicability of the "no-cost" warranty concept, and the inaccuracy of the reference cited, the policy remains in effect today and is strongly supported by the ASN staff (Enter, 1994).

D. ACQUISITION STRATEGY, PROGRAM MANAGEMENT, AND WARRANTIES

"Acquisition Strategy" has been defined many different ways. Once referred to as "the conceptual basis of the overall plan that a Program Manager follows in program execution" according to the Acquisition Strategy Guide (ASG) (Nelson and Balaban, 1984), it is "the framework for planning and directing the program". The ASG was written for the Defense Systems Management College (DSMC) which provides advanced professional training for all DoD acquisition professionals.

The DSMC approach to Acquisition Strategy requires the Program Manager to consider a multitude of criteria that can impact the development and delivery of a weapon system over the entire life cycle. The considerations they list include such nebulous concepts as realism, stability, resource balance, flexibility, and controlled risk. The Program Manager must assess the impact of each of these continuously from the "definition of the mission need" phase of development all the way through the "support and operation" phase and on to the weapon system's retirement.

The key to developing a successful acquisition strategy involves integration of the acquisition process with the known trade-offs between cost, schedule and performance. Additionally, the strategy must addresses alternatives, resources, timing, methods, goals and risks. It is also important to note what Henry Mintzberg stated recently in his article on strategic planning (Mintzberg, 1994). "Strategies

cannot be created by analysis, but their development can be helped by it."

What does all this mean in the context of program management and warranties? The Program Manager is the only individual who has the total "big picture". As such, the PM must understand that the concept of warranties is but another risk management tool, which should be used to assist him or her in obtaining improved system performance and resource economy. Particularly, in today's context where the use of warranties is mandatory for production contracts, consideration as to how they are to be employed must be done early if they are to be effective.

The use of warranties should not come as a surprise to the contractor. The terms and criteria on which the essential performance requirements (EPRs) are based should be established early in the program life cycle and support legitimate mission needs of the program. One of the most important benefits of a warranty is the incentive to the make the contractor honest regarding its capacity to obtain a given EPR. Unwillingness to stand behind an EPR with an explicit warranty is indicative of a contractor's uncertainty or inability to meet established design and performance criteria. Early knowledge of this allows the Program Manager to reevaluate the risk to the program should the contractor not meet the EPR and develop alternative courses of action for obtaining the program's goals.

E. NAVY AIRCRAFT ENGINE PROGRAM MANAGEMENT

There are several aspects of the Navy aircraft engine program management and logistic support system that are unique with respect to other major weapon systems. These differences need to be understood in order to have a full appreciation for the management challenges they represent and their impact on warranties.

1. Acquisition Management

First of all, aircraft engine procurement does not fall under the responsibility of a single Program Manager for Acquisition (PMA) like most major weapon systems. Although the majority of responsibility for management of the program lies within AIR-536, the ultimate responsibility lies with the aircraft PMA. From both a funding and scheduling perspective, all aircraft engine development and procurement actions are driven by the host aircraft acquisition plan. Even though the size of most engine programs is larger than many separately managed weapon systems, they represent only a segment of the total procurement package being managed by the aircraft PMA.

AIR-536, as the Propulsion and Power Division for the Assistant Commander for Systems Engineering (AIR-05), performs its primary function as the engineering class desk for engines. Its secondary role becomes that of the acting engine PMA for the aircraft PMAs.

An additional aspect which makes the Navy aircraft

engine acquisition program management unique, with respect to the applicability mandated warranties, is that engines are not major weapon systems as defined by Section 2403. It is only the language in the DFARS Subpart 246.770-1, that expands the warranty requirement by defining a weapon system as "a system or subsystem" and lists propulsion systems for inclusion, which makes the mandated warranties applicable to aircraft engines.

2. Logistics Management

Although the structure of the acquisition program management setup is different, the logistics management is not. Much like a other major programs, engines have a dedicated logistic support team headed by an Assistant Program Manager for Logistics (APML) within the Aircraft Systems Branch of the Logistics Management Division (AIR-410). Under the cognizance of the Assistant Commander for Fleet Support and Field Activity Management (AIR-04), the APML manages all aspects of engine logistic support "from soup to nuts".

3. Component Improvement Program

Another unique aspect of the Navy aircraft engine program management which needs to be discussed is the Component Improvement Program (CIP). The CIP applies specifically to aircraft engines and plays a vital role in improving the availability of mature systems in the fleet. Funded through research and development funds, the purpose of

CIP is to identify and correct emerging engineering and logistics problems. This effort is obviously directly affected by the role warranties are expected to play in addressing performance problems in the post-acceptance period. The economic relationship between CIP and warranties will be expanded upon in Chapters III and IV.

4. Fleet Inventory Management

The Navy Type Commanders (TYCOMs) are responsible for the overall inventory management and distribution of aircraft engines and modules used by the operational units under their cognizance. Assisted by the Aircraft Engine Management System (AEMS) computer program, the staffs are responsible for monitoring the availability of all engine systems assigned. They assist in determining depot workload and distributing engines for repair within the three intermediate maintenance levels. These managers strongly support the overall engine program. Because they are the customer's liaison, their participation in engineering and logistic management reviews ensures the Fleet's requirements are adequately represented.

5. Maintenance Management

The maintenance management system for aircraft engines is different than that of most repairable items and as such has a significant impact on warranty administration. In addition to the organizational and depot levels of maintenance, there are three levels of intermediate

maintenance support. They are designated as first-degree, second-degree or third-degree maintenance facilities and their capabilities range from complete engine repair (CER) to limited, respectively. Their capabilities are tailored depending on the number and type of aircraft supported and the needs of the Fleet. Obviously, logistic considerations include the size of the facility, transportation, support equipment and manpower. Additionally, because they are TYCOM-managed assets, activities which are directed to send an engine or module to the next higher level of intermediate maintenance do not incur a charge to their aviation depot level repairable (AVDLR) maintenance budget.

III. ECONOMIC PRINCIPLES OF WARRANTIES

This chapter presents the economic principles that apply to the issues of weapon system warranties. It elaborates on the theoretical differences between warranties as they are used in weapon system procurement and as are used commercial applications. It explains the classification of warranty types as a result of their function and their applicability for use in weapon system production contracts. Additionally, it discusses how warranty costs are determined and their impact on Life Cycle Cost (LCC).

A. WARRANTY THEORY

1. Warranty Defined

The word "warranty" has been expressed in many different ways. In fact, Section 2403 uses the word "guarantee". For all intents and purposes, the word warranty and guarantee are considered interchangeable. In the context of DoD weapon system acquisition, the definition that was developed and adopted by the IDA for its report was:

> A legally binding guarantee - usually explicit but in certain cases implicit- whereby a contractor, with or without an explicit payment, agrees to remedy defects in design, manufacture, workmanship, materials or performance existing at a specific time or emerging over a specific period in a weapon system. It may, in addition, provide positive incentives to exceed target specifications in these characteristics, or penalties if specified targets are not achieved.(Kuenne, 1987)

The term "defects", as used in the definition above refers two distinct types of defects. The first, which is referred to as a "patent" defect, is a condition or characteristic that is found through the inspection or acceptance process to not be in compliance with the contract requirements. The second type is referred to as a "latent" defect. It is so called because it is a defect that exists at the time of acceptance but does not become apparent until sometime after.

2. Warranties in Weapon System Procurement

The economic theories that explain the roles and relationships of the warranties used in weapon system procurement include the economics of uncertainty, insurance theory, and the principal-agent theory. The differences between the economics of warranties commonly used in commercial applications and those used in the procurement of weapon systems by the DoD are significant.

In commercial applications, the risk and associated costs of a warranty are spread out, incrementally, over a large number of customers, who have little or nothing to do with the design, development or specifications of the product they purchase. This is obviously not true in the case of major weapon systems bought by the DoD. When a contractor enters into a warranty agreement with the DoD, the risks and the costs associated with that warranty are assumed by only two

parties, the government and themselves.

It can, therefore, be established that the effective use of warranties in weapon system procurement centers around the distribution of risk and the level of uncertainty. According to economist Frank H. Knight there is a difference between risk and uncertainty. In his book "Risk, Uncertainty, and Profit" he explains that risk is based on the probability outcomes and can be determined mathematically by the variance of the outcomes as compared to the predicted and therefore be insured against. Uncertainty on the other hand, relates to unique events and results in a situation where the outcome can only estimated subjectively. More important, either party's ability to assume risk has the greatest bearing on the effectiveness of the warranty (Kuenne, 1987).

The academic works and economic theory reviewed support the notion that the federal government, as an entity, is much better able to absorb the loss if a weapon system does not function as requested in the post-acceptance period than is the prime contractor. In economic terms, the contractor is more "risk-averse". It follows then that, the government should not be encouraged to buy "insurance" from any contractor. To quote the IDA Paper, "There is, therefore, a perverse element in the purchase by DoD of insurance from contractors who (as a group) have been shown in empirical studies to be quite risk-averse."

B. CLASSIFICATION OF WARRANTY TYPES

Warranties can be classified by the function they perform. In general, warranties serve three basic functions in the procurement of weapon systems; assurance, insurance and incentive. Each type of warranty, or function, has its own set of implications and effects discussed below.

1. **ASSURANCE:** The most basic of warranty functions. As the word suggests, it "assures" the DoD that the delivered product complies with the design and manufacturing specifications and conforms to the materials and workmanship requirements of the contract. Its effective period ends, with respect to patent defects, at acceptance and for latent defects after some reasonable period of time thereafter.

2. **INSURANCE:** Another basic function. All warranties provide some measure of insurance. Even those clauses which are more closely related to the assurance function provide some measure of protection against the risk or cost of repair or replacement. This function really becomes significant when the clause covers an extensive period of time beyond acceptance.

3. **INCENTIVE:** The incentive function, usually a negative one, is present in all warranties to some degree as well. This is particularly true when the contract language provides explicit rewards or penalties associated with meeting or exceeding specific performance goals or targets.

Most of the literature written on weapon system warranties emphasizes the use and effects of assurance warranties. The use of incentive warranties has had some historical success in obtain better operating performance in certain Reliability Improvement Warranties (RIW). Despite this fact, the current use of incentive warranties in production contracts is limited. There is very little consideration given to the use

of insurance warranties. In fact, the original "Warranty Handbook" (Balaban, 1986), used at the Defense Systems Management College, does not even discuss insurance warranties. This omission is appropriate because of the unique relationship between the DoD and the weapon system contractors with respect to design of the product and the nature of risk.

C. WARRANTY COSTS

This section introduces the concepts and theory associated with warranty costs and focuses on the concept or notion of the "no-cost" warranty.

Weapon system warranty costs are real. Borne either by the contractor or the government, they represent a substantial investment and should not be taken lightly. Balaban's analysis of data available from recent warranty programs indicated that a "typical" warranty meeting the minimum Section 2403 requirements costs the government approximately two and one half percent of the total hardware cost for each year the warranty is in effect. This is high when compared to the contractor's actual warranty cost which he estimated at only one and four tenths percent of hardware cost per year. (Balaban, 1994) If the programs that he analyzed are an accurate representation, then the up-front costs associated with buying warranties for major weapon systems could be several billion dollars a year.

Several elements make up the total warranty cost. It

should be clear when discussing warranty costs what that cost includes. For continuity purposes the basic definitions used by Mr. Balaban are para-phrased below.

1. **Contractor Warranty Cost:** the dollar value included in a contract for the contractor to supply the warranty.
2. **Contractor Warranty Price:** the contractor warranty cost plus profit.
3. **Total Warranty Cost:** the contractor warranty price plus additional Government cost to administer the warranty.

As the IDA Paper warranty definition indicated, the payment a contractor receives for entering into a warranty agreement may not be explicit. When the cost of a warranty to the government is not negotiated separately, as is the case when the Navy pursues a "no-cost" warranty, it does not mean that the contractor warranty cost is zero. What it does mean is that the Navy does not allow for any additional explicit costs.

According to the ASN Warranty Policy memorandum,

> it may be reasonable to consider through additional profit the added risk to a contractor for cost which may be incurred in satisfying the conditions of a warranty.

The suggestion made by this statement, that the cost associated the added risk of a warranty be applied through additional profit, supports the notion of implicit payment of the contractor warranty costs. It is obvious that this is truly not a "no-cost" warranty. Unfortunately, without an explicit representation of this cost to the government, the

contractor warranty cost and contractor warranty price appears to be zero. Additionally, when the contractor warranty price is not discernable it is virtually impossible to conduct a realistic warranty cost-benefit analysis.

1. Assurance Warranties

At the time of acceptance, the DoD has the right to receive from the contractor a system that meets the specifications that were contractually agreed upon. Accordingly, no additional price should be paid for a warranty that guarantees a product that meets the configuration specifications and performance requirements of the production contract. To do so would be to pay for the same risk twice; first, implicitly in the price of the contract, and second in the price of the warranty. Again, this does not mean that the warranty is free. It simply means that all costs associated with the risk of correcting patent defects discovered during inspection or acceptance testing and latent defects for some "reasonable" period of time afterward should be included in the cost of the item.

2. Insurance Warranties

A warranty whose primary function is to insure the government against future costs will bear some additional cost. The amount of cost associated with an insurance warranty is based on the risk-averse nature of the contractor and the risk associated with meeting the terms of the warranty

specification with respect to the duration of the period covered and the variability of outcomes.

3. Incentive Warranties

The costs associated with incentive warranties are associated with the ability of the contractor to affect an increase in the quality of specifically requested parameters. Often associated with the "win-win" scenario, the government and contractor assume the relationship of principal and agent, respectfully. Through the use of the profit motive, the government seeks to provide incentives to the contractor to improve quality.

D. THE "NO-COST" WARRANTY

The Navy has been openly criticized by several OSD personnel interviewed in this thesis research for its use of the "no-cost" warranty. This section will discuss the theory of the "no-cost" warranty and the effect of its use by the Navy. This section focusses on material obtained during an interview with Mr. Harold S. Balaban on 24 February, 1994.

During our discussion (Balaban, 1994), Mr. Balaban stated that the "no-cost" warranty issue paper was written in anticipation of a formal request for analysis that never materialized. Excerpts from an unpublished paper written by Mr. Balaban in October of 1985 have been included here because of their particular relevance and applicability. It was provided to the author in its original, unedited format. It

adds a good perspective to this controversial issue.

> The services have responded to the legislative requirements and almost every covered equipment has a warranty that meets the law's basic requirements. While the real benefits of this legislation remain to be determined, it became very clear that the warranties will not be secured free. ...the idea of a "no-cost" warranty has become prominent in some circles. It is the author's contention that this idea in most cases today is not realistic and, in fact, could very well be counter productive.

The rationale for such a policy has some logical basis. Here is Mr. Balaban's explanation.

> In a typical military procurement, the government has told the contractor what it wants and, through the Full Scale Engineering Development phase, has paid the contractor to develop the product. Therefore, there is no reason to pay additional monies for a warranty which provides contractual assurance that the contractor meets stipulated performance and reliability requirements that he has already been paid to meet.

However, Mr Balaban quoted one Government business manager as saying "the Government pays for everything so a "no-cost" warranty is only a myth." As stated in the section above on warranty costs, any warranty must involve some administrative costs, so the "no-cost" aspect of the warranty refers to the contractor's warranty cost. The problem you encounter with the logic of a "no-cost" warranty is what Mr Balaban refers to as the "no-cost" paradox. He describes it by telling the following story:

> Assume that all factors point to a "no-cost" warranty; therefore, one is written for a six month period to cover conformance to design and manufacture defects in workmanship and stated essential performance requirements. The contractor agrees, but just prior to signing the contract, a young government contracting intern suggests

that if a six month warranty is good wouldn't a one year warranty be bet er? And wouldn't a two or three year warranty period e even better? Clearly, at some point the contractor takes a stand and insists on covering his increased risks.

If you agree to the theory that warranty costs increase with warranty duration, then it is clear that there is no such thing as a true "no-cost" warranty. Warranties may appear to be at no cost, only because the contractor has figured a way to "bury" the costs associated with the risk for warranty of short duration somewhere else in the contract. The other reason might be that the perceived risk associated with the warranty specifications is so small that the contractor is not worried about it.

As stated earlier, the idea of a "no-cost" warranty can have merit. There are certain conditions for which a "no-cost" warranty is logical. In such cases, the Government should not pay for conformance to specifications which it has previously paid for in both the development and production contracts. The other argument made is that by forcing the expected costs of uncertain technology into the purchase price of a system by means of a warranty, it provides the government a means of capturing the true costs. The system cost can therefore be accurately matched against proposed benefits (Kuenne, 1987).

E. WARRANTIES AND LIFE CYCLE COSTS

To be certain, warranties, either implicit or explicit, have an effect on the Life Cycle Cost (LCC) of a weapon

system. Measuring the effect of a warranty on the LCC is not an exact science. To assist the Program Manager, several cost -benefit analysis models are currently used within NAVAIR. AIR-524 has the responsibility for maintaining these models and conducting the actual cost-effectiveness analysis (CEA).

The models attempt to ascertain the cost effectiveness of the warranty through standard LCC analysis methodology developed to define and document the effect. The purchase of a warranty is deemed to be cost-effective if the calculated life cycle cost estimate with a warranty is less than or equal to the life cycle cost if no warranty was purchased. It is obvious in the Navy's case where a "no-cost" warranty policy has been adopted that the outcome of this analysis will always favor the adoption of the warranty.

A warranty CEA is performed by comparing the cost of purchasing a warranty with the benefits accrued over a system's useful life. The benefits received from the use of a warranty can be categorized into three general areas. They are those benefits that result from expected events, benefits that result from unexpected events and intangible benefits. Each category will be explained further.

The benefits that result from expected failures being covered by the warranty come primarily in the form of reduced maintenance costs. All systems fail at some expected rate. Warranties clauses that cover the costs associated with these types of expected failures fall into this first category.

Warranties that attempt to relieve the Program Manager of need to provide for either the Navy's own internal "organic" maintenance support capability or commercially provided maintenance support are frowned upon by legal council (Townsend, 1994).

Benefits also result from unexpected events, such as an item which displays an unforeseen reliability problem. Failures of a random nature occurring at a rate greater than the expected reliability of the system are categorized as unexpected as well. Failure to meet selected essential performance requirements (EPRs) that extend over a long period of time is another example of unexpected failures.

Coverage for these items can often be categorized as an insurance warranty. The actual dollar value, and therefore the cost of protection provided by a warranty for unexpected failures, is a function of the aversion to risk. A Program Manager who is willing to assume the risks associated with unexpected failures or defects may place a small dollar value on the benefits derived from such a warranty.

The last category includes those intangible benefits that result from the use of a warranty. They include the incentive to the contractor to provide a quality product because of the potential cost and risk of a warranty requirement as well as the ability of the Navy to operate without the risk of an unexpected catastrophic failure. The value of such intangible benefits is, once again, a function of aversion to risk.

Once determined, the value of each type of benefit is included in the warranty cost analysis and the comparison is drawn.

As stated earlier, the warranty cost effectiveness is determined by first comparing the weapon system life cycle costs with a warranty to the same system without a warranty. The costs to be considered in a warranty LCC analysis can be broken down into five categories:

1. Warranty price: This is the actual price paid to purchase the warranty from the manufacturer. It is the negotiated dollar figure stipulated on the contract that serves as payment for all the manufacturer's warranty costs including administration, repair and any other corrective action required under the terms and conditions of the warranty.

2. Warranty administration: This is the estimated cost for the government to maintain a warranty contract. It includes such costs as those in instituting special procedures, and the administration of warranty claims.

3. Non-warranted repair actions: This is the estimated costs for repair actions not covered by the warranty, or repairs on systems whose individual warranty has expired.

4. Unprocessed claims: This is the estimate for all claim actions not properly exercised or executed.

5. Other corrective action: This estimate covers the government's cost to make any other corrective action necessary. They would include the cost of engineering changes not covered under the terms of the warranty and those that are incurred after the warranty has expired.

There are numerous variables considered in the current CEA models being used. The following represents a sample of some of the more widely used service-provided variables:

1. Equipment economic life: The period of time the system is expected to be in inventory.

2. Discount rates: The rate used to account for the time-value of money.

3. Escalation rates: the inflationary or deflationary effects on costs over time.

4. Constant dollar base: The value of a dollar, based on a given date, used to ensure consistency throughout the analysis.

5. Usage rates: The estimated usage expected on a per-system basis over time (ie., hours of use per month).

6. Valid claim rate: The historical percentage of successful claim actions for all past claims initiated.

7. Repair cost: The estimated cost to repair the item, given the logistics and maintenance support plan.

It must be re-emphasized that the actual values used in the formulation of the CEA represent the service's best estimates and are not necessarily what will occur in the future.

The following represents a partial list of variables that the contractor must provide for the model. These are mostly estimated values.

1. System reliability: This is usually an estimate of the mean time between failures of the system.

2. Warranty fixed costs: The costs incurred by the contractor to establish a warranty program regardless of the number of claims.

3. Variable repair cost: The average expected per unit cost to effect a repair action covered under the terms of the warranty.

4. Variable costs for other corrective actions: The average expected costs in correcting deficiencies other than

repair. It includes the cost of preparing and implementing engineering change proposals (ECPs), and other such remedies as appropriate.

In accordance with the DFARS Subpart 246.7, the terms and conditions of a particular weapon system warranty can be "tailored" by the contracting officer to ensure that the warranty is "cost-effective". From a review of the variables used in the performance of the CEA, it can be seen that the terms and conditions of the warranty will undoubtedly have a direct impact on the Component Improvement Program (CIP) discussed earlier.

F. WARRANTIES AND THE COMPONENT IMPROVEMENT PROGRAM (CIP)

As introduced in Chapter II, the CIP was established to address many of the same emerging technical problems impacting system performance, reliability and availability covered by production contract warranties. If both programs cover the same problems, the real question here is which one does the job better and why.

The CIP uses actual Fleet usage data to obtain information on current system degraders and performs both engineering and life cycle cost analysis to determine the effectiveness of any action before it is taken. Resources are then allocated in current year dollars based on urgency of need, customer demand and expected return on investment. These funds can be use to fund either commercial or Navy efforts to provide solutions to

problems that surface during the post acceptance period and are seen as very low risk.

Occasionally, unexpected reliability problems or latent defects surface within the first six months to one year of a new system's fleet operation. These failures are most often covered by standard warranty clauses covering freedom from defects in materials and workmanship, and conformance to design and manufacturing specifications. As an assurance warranty, the cost of providing remedy to such failures is normally included in the cost of the production contract either explicitly or implicitly.

The type of warranty that would most likely duplicate the efforts covered by the CIP is an insurance warranty. As presented earlier, economic theory suggests that the use of insurance warranties is the least effective of the three types of warranties used by the government. This is particularly true for the DoD, not only because of the economic principles, but also because of the impact of the policies and administrative rules that apply to weapon system warranties. The analysis of these factors will be presented in Chapter IV.

IV. ANALYSIS

This chapter presents the findings of the economic analysis of the mandated weapon system warranty requirements set forth in Section 2403, the FAR and the DFARS both in theory and in practice. The outcome of the policy analysis conducted on the current DoD/DoN warranty guidance directives is presented as well. The chapter concludes with an assessment of the warranty program management from all levels within the DoD that impact the NAVAIR engine Program Managers in the development of warranties that are compatible with the engine and aircraft acquisition strategy.

A. ECONOMIC ANALYSIS

1. The Law (10 U.S.C. 2403)

This section will individually review each of the major provisions of Section 2403 in order to better analyze their economic characteristics and determine the overall effect of the law. First of all, Section 2403 requires the DoD to obtain a written guarantee from the prime contractor that contains three basic elements: conformance to design and manufacturing requirements; freedom from defects in materials and workmanship; and conformance to essential performance requirements (EPRs) specifically delineated in the contract.

The first two elements, design and manufacture, and

materials and workmanship, merely represent a codification of standard DoD practices and do not pose any new or meaningful consequences. They are essentially assurance warranties. Because these types of warranties simply assure that the government gets what it paid for, separate line-item pricing is not considered appropriate (Kuenne, 1987). This inclusive pricing method is appropriate only if the duration of the warranty period is reasonable. The period covered must be long enough to protect the government from latent defects discovered during the initial operating period but not be so long as to take on the characteristics of an insurance warranty.

The law's third mandated element, conformance to EPRs, represents a new and additional requirement. The use of EPRs extends the requirement to maintain performance standards into the post-acceptance phase. EPR clauses are normally categorized as either assurance or insurance warranties but can be structured as an incentive warranty as well. The categorization of an EPR as an insurance warranty is based on the economic principles of uncertainty and is dependent upon three factors. First is the duration of the warranty, second is the contractor's level of control over the product quality during the warranty period and third is the difference in extent of the contingent liabilities in the event of a failure in the post-acceptance period as compared to those discovered during the inspection and acceptance procedures. The liability

differential would include such things as the costs of shipping and handling of warranted systems to and from the contractor's repair facility, and the retention of contractor personnel necessary to handle any failures or redesign efforts that may be required. As such, what specifications are chosen to be EPRs and how the clauses are written in the warranty are the sources of the greatest potential economic impact.

Whether Congress intended EPRs to reflect the operational capabilities (OCs) or reliability, maintainability, availability characteristics (RMACs) of the weapon system is a continued source of debate (Kuenne, 1987). The law authorizes the Secretary of Defense to determine whatever characteristics are considered "to be necessary for the system to fulfill the military requirement for which the system is designed". Many of the warranties reviewed as part of this study contained both OCs and RMACs as EPRs.

The potential impact to the system's life cycle cost if RMACs are not met is significant. Unfortunately, the uncertainty associated with maintaining the specified level of performance for an extended period of time beyond acceptance is extremely high as well. Accordingly, RMAC EPRs are less efficient as they tend to fall into the category of insurance warranties because of the three factors mentioned earlier; warranty duration, level of contractor control, and difference in contingent liabilities. The risks associated with maintaining a level of performance for OCs, which are

rigorously tested and proven during system development, are more readily discernable. The duration of the EPR warranty clauses associated with the vast majority of OCs is less than that of RMACs and can be categorized as assurance warranties. So it is seen again that which specifications are chosen to be included as EPRs can have a significant difference in the economic effects of the warranty.

One of the more economically significant provisions found in Section 2403 is the one that authorizes the negotiation of specific details of the warranty including reasonable exclusions, limitations and time duration. By authorizing the negotiation of the specific details of the warranty, the law allows the DoD and the Program Manager the latitude to implement a warranty that "fits" the needs of the program. It is through this tailoring action that the type of warranty is determined and the cost effectiveness of the three required elements in the warranty are affected.

The law does not specify which type of warranty is to be used. Accordingly, it has little impact on the economic efficiency of the warranty itself. It is important to remember that it is the type of warranty used, or the function it is intended to perform (assurance, insurance, or incentive) and the risk-averse nature of the parties involved that has the biggest impact on warranty cost and effectiveness.

The economic efficiency and cost-effectiveness of the different warranty types, drawn from the analysis and research

conducted as part of the IDA Paper (Kuenne, 1987), are summarized below:

1. Assurance warranties are an integral part of the production and delivery of the systems, and their costs cannot be separated from the costs of production. The DoD should be careful not to pay twice for the right to receive what was contractually agreed to in the contract.

2. Insurance warranties which attempt to shift all or a major portion of the risk of substantial loss in the post-acceptance period to the prime contractor are not cost-effective for the DoD.

3. Incentive warranties can be an effective instrument to encourage the contractor to meet or exceed target parameters when the contractor has control over those characteristics and is responsive to the monetary incentives offered.

With regard to remedies, the law allows the Secretary of Defense the discretion to require the contractor to take prompt corrective action to correct the failure at no additional cost or to pay any reasonable costs incurred by the government to do so. The first alternative can create considerable additional risk for the contractor if the period of the warranty extends significantly beyond the production schedule. This is particularly true if redesign is determined to be required. Historically, once the production line is shut down, artisans and engineers are reassigned to other programs or let go. In order to cover warranty requirements in the post-production period, the contractor might be required to carry those personnel on its staff in a less efficient capacity or contract for services on an as-needed basis. In

either case, as an additive requirement these costs would have to be included in the contractor's warranty cost.

When the second remedy alternative of reimbursing the government is chosen, neither the DoD nor the program office is assured of receiving direct compensation for expenditures undertaken in correcting a warranty breach. In fact, the standard procedures established in the FAR require that any reimbursement received as warranty compensation be forwarded to the Treasury Department for deposit in the General Fund. When this is the case, there is no incentive for the Program Manager or the Contracting Officer to pursue such reimbursements. Fortunately, provisions in the law and initiatives taken within the DoD attempt to alleviate this situation and properly incentivize the program office to pursue and manage a more effective warranty.

The law permits the DoD to reduce the price of any future contract for a weapon system or other defense equipment with the contractor to compensate for any payment due. The Program Manager's ability to receive "direct compensation" through the reduction of its future contract prices for a warranty that was paid for out of the program's limited procurement appropriation funding is considered a critical incentive element. Another initiative aimed at correcting this incentive problem was related to the researcher in an interview with Ms. Susan Grant, from Business Management Directorate of the Office of the DoD Comptroller. She

explained that the Comptroller's Office had recently succeeded in using warranty reimbursement paid to the Treasury as justification for supplemental appropriations for a particular program. (Grant, 1994).

Whether or not any of these provisions provide the Program Manager the proper incentives depends on the systems acquisition strategy. For example, if the duration of the warranty extends well beyond the planned production schedule, then there is little or no opportunity for the Program Manager to recoup any of the limited program procurement funds spent on an expensive warranty through the reduction future contract prices or reimbursement.

The last provision of the law covered in this section is the one governing waivers. Section 2403 authorizes the Secretary of Defense to waive any or all of the required warranty clauses if they are found not to be cost effective or the waiver is necessary in the interest of national defense. By doing this, the law makers have provided the DoD and its Program Managers the means to avoid entering into any unproductive warranty agreements and the ability to determine effectiveness on its own terms. To date, only two major weapon systems have successfully processed waivers (Brooks, 1994). The requirement to notify all of the interested committees in Congress makes the process particularly laborious. The majority of Program Managers view this unnecessary program visibility as high risk and therefore opt to pursue other

alternatives.

So it can be seen that it is the DoD's interpretation of the law with regards to the Congressional intent of EPRs, the articulation of specific warranty terms and conditions, and the influence of the reimbursement procedures and the system's acquisition plan on the Program Manager's incentives that have the most significant impact on the economic effects of a weapon system warranty. In theory, the DoD has the ability and the latitude to develop, write and execute effective warranties with minimal adverse economic impact or inefficiency.

2. The FAR and DFARS

The warranty sections in both the FAR and the DFARS reduce some of the potential economic inefficiencies of Section 2403 by reducing ambiguity, providing guidance and allowing for even more self-determination. It is important to recall that the FAR covers all government procurement actions; not just weapon systems. According to Subpart 46.7, Warranties (Appendix D), the use of warranties is not mandatory but when one is obtained it should be cost-effective.

The FAR gives the agency or department issuing the contract the authority to include warranties and requires Contracting Officers to consider various factors and the FAR's general guidelines when determining if the use of a warranty is appropriate. In and of itself the wording of the FAR has no

major impact on the cost effectiveness of a warranty. There is, however, the potential to avoid inappropriate warranties if the Contracting Officer has a good grasp of the factors they are charged to consider and the economic impact of using them.

Conversely, the amplifying direction given in the DFARS, Subpart 246.7--Warranties, has significant potential impact on the economic efficiency of weapon system contracts (Appendix E). Subpart 246.770 of the DFARS covers the policies and procedures for weapon system warranties and includes all of the basic provisions found in Section 2403. By allowing the cost of a warranty to be included in the item's price, Subpart 246.703 allows the warranty cost to be hidden and therefore precludes any useful cost analysis.

This can be seen in the Navy's contracts that do not include a separately priced line item for the cost of a warranty. This practice was adopted as a result of the 1986 warranty policy guidance from the Assistant Secretary of the Navy Pyatt (Appendix I). A recent change in Navy contracting policy does now permit separate cost accounting for the cost of contractor warranty administration.(Townsend, 1994)

The DFARS Subpart 246.770-2 requires that a warranty identify redesign as a potential remedy. This provision, which is included in the multi-service generic aircraft engine warranty (Appendix C), exposes the contractor to significantly greater risk, particularly for EPR warranty clauses. The Navy

management views this provision as a requirement for the contractor to provide "no-cost" engineering change proposals (ECPs). The redesign provision is a serious concern to the Navy Program Managers because of the potential cost to the program to fund such an effort. As will be seen in the section on aircraft engine warranties, the contractors are equally aware of the uncertainty and potential costs involved in a redesign effort and strive to limit their liability to cover such costs in the warranty.

Provisions for redesign have been recently negotiated in the T-45 program reflect this point. According to CDR Wagner, the T-45 Assistant Program Manager for Logistics (APML), in recent contract negotiations with McDonnell Douglas, the contractor was willing to pick up only the costs of redesign and those associated with implementing any changes required in the production line for future deliveries. They were not willing to pay the costs associated with any retrofit action required for spare components in the Navy inventory (Wagner, 1994).

The DFARS Subpart 246.770-3 expands on the Section 2403 provision concerning the tailoring of warranty terms and conditions. It permits Contracting Officers to limit the contractor's financial liability if it is necessary to make it cost-effective and to negotiate the duration of performance warranties. This can result in the Contracting Officer taking a short-range economic perspective and is not conducive to

reducing a weapon system's total life cycle cost.

When a Contracting Officer is in negotiations, he/she is representing the Program Manager. Restrained by financial resources, they often are placed in a position where they are forced to buy as much warranty as they can afford (Wagner, 1994). Their focus is forced to be on the availability of current year procurement funding, in this case Aircraft Procurement, Navy (APN). They do not always have the information necessary to make an assessment of the impact that the tailoring action will have on future year Operations and Maintenance, Navy (O&MN) or Research and Development (R&D) funding.

According to the DFARS, Subpart 246.770-7, in order to assess the cost effectiveness of a proposed warranty, the services must perform a cost-benefit analysis that considers both the quantitative and qualitative costs and benefits of the warranty. It goes on to list a number of costs and benefits to be considered. In the Navy's case the most important cost component of this analysis, the cost of warranty acquisition, is considered to be zero. This fact has led to a somewhat indifferent perspective among program management and contracting personnel regarding the importance or significance of conducting a cost-benefit analysis. This perspective was evident during an interview with the Program Manager from AIR-536 responsible the Rolls-Royce F405 engine. When asked if it was possible to review the results of the

warranty cost-benefit analysis on the new contract for F405-RR-402, the Program Manager indicated that there was no warranty cost-benefit analysis filed. (Dabney, 1994)

It is truly necessary that the Contracting Officer understand the nature and use of the system being procured, as well as the acquisition strategy and logistic support plan. With this information and an understanding of the trade-offs between the potential costs and benefits, and the difficulty of administering and enforcing a warranty, they can accurately assess the value of the specific warranty language used.

B. POLICY ANALYSIS

This section presents the analysis of the current policy and directives issued from both Department of Defense and Department of the Navy governing weapon system warranties.

1. Secretary of Defense

As presented in Chapter II, The Office of the Secretary of Defense (OSD) for Procurement Policy supports a repeal of the current law mandating weapon system warranties. Accordingly, as one would expect they have maintained basically a "hands off" policy with regards to the way in which the services manage their warranty programs. This is evidenced by the lack of specific guidance put forth from its level. As mentioned in Chapter II, the newly issued DoD 5000 series instructions which govern the Acquisition Program do not devote any coverage to warranties. Has this policy been

effective? Obvious problems have arisen from the lack of guidelines standardized across the services for developing, negotiating, administering and determining the cost effectiveness of weapon system warranties.

The current policy and position has contributed to the diversity of how the services handle warranties and the general confusion over the issue of their cost effectiveness. This can be seen in simple ways such as the lack of consensus among the services and agencies within the DoD with regard to their position on the law and desirability of warranties as reported in the 800 Panel Report. Much of the current political activity surrounding weapon system warranties is based on this issue as well.

The emphasis of the Glenn Bill (Appendix D) was to task the DoD by amendment to the current provisions of Section 2403 to provide the guidance necessary to alleviate much of this confusion. Although the majority of people involved in the political arena do not fully understand the economic nuances of weapon system warranties, they do understand the concept of quality. Many of them see warranties as some sort of "hammer" that will guarantee that they get a quality product from the manufacturer. Accordingly, they see the DoD's recommendation to repeal the current statute as a reluctance to take charge of this program and to enforce quality standards on the weapon system contractors. This is definitely not the case.

In a recent interview with the Director of Defense Procurement, Ms. Spector said that the primary reason the OSD does not support the current law is that it simply has not been effective in bringing about the quality and cost efficiencies expected. This point is true. As it stands, the law certainly cannot, and does not, ensure that the DoD obtains a quality product. Furthermore, historically, production weapon systems procured with the mandated warranty clauses have cost the government more than the benefits they have provided (Balaban, 1994).

Ms. Spector did, however, reiterate the myriad of ways the DoD acquisition program emphasizes accountability and ensures quality in weapon systems procurement. She noted that, in addition to the extensive training Program Managers and Contracting Officer receive, the program management review process provides for in depth system reviews every step of the way. She did acknowledge however, that there currently is not a requirement to review warranty plans or provisions as part of the Defense Acquisition Board (DAB) review process. By including the requirement to review the warranty plan as part of the DAB review, there would be an opportunity to identify potential problems before they manifest themselves.

The difficulties associated with warranty administration have been pointed out by both the GAO and the DoD Inspector General and acknowledged by the OSD. Unfortunately, continuing to focus on the need for improved

warranty administration is like a physician prescribing a medication that addresses a patient's symptoms without treating the illness itself. Far too much effort has been put forth by countless people in search of better warranty administration.

The Joint Aeronautical Commanders Board sponsored a sub-group that has been working for months just on developing the appropriate wording to be used aircraft engine warranties. Its efforts have not begun to deal with the effectiveness issues of warranty duration and application of particular EPR's. It is interesting to note that the Army thinks the issue of developing effective weapon system warranties is so important they have teamed up with The Society of Logistics Engineers (SOLE) and put together a three-day warranty training seminar. As a product of the Joint Army Industry Warranty Working Group (JAIWWG), the seminar is designed to go beyond the current DSMC Program Managers Course which is required as part of DAWIA to educate acquisition personnel.

In conclusion, the OSD warranty policy is not effective. What is needed to remedy this problem is the establishment of simple and clear guidelines that apply to all services, that these guidelines insure the economic considerations of warranties are part of the weapon system development and production and, finally, that an established formal review process be instituted.

2. Secretary of the Navy

As introduced in Chapter II, the significant formal policy guidance from the ASN staff was contained in Pyatt's letter in 1986 (Appendix I). Although the memorandum supports the use of the warranty clauses mandated by Section 2403, the discussion on relevant warranty costs has had a profound effect on how the Navy does business. The impact can be seen in NAVAIR as they continue to pursue "no-cost" warranties and are unable to perform useful cost-benefit analyses. Some of the negative aspects of the "no-cost" warranty policy anticipated by Mr Balaban in his unpublished report (Balaban, 1985) prior to the Navy's adoption of this policy have materialized. Summarized below they are:

1. Warranty terms and conditions will be limited. You get what you pay for.
2. True warranty costs may be hidden in other line items. The Navy does not really know what it is paying for and meaningful cost-benefit analysis will not be possible.
3. If the "no-cost" warranty places a contractor in serious financial jeopardy, he may decide to go to court. If they can convince the court that the Navy required a "no-cost" warranty even though the conditions for such a warranty did not exist, then they are likely to win.

In essence, the Pyatt memorandum did not mandate the use of a "no-cost" warranty, but the end effect was the same as if it had. This has proven to be one of the biggest stumbling blocks with regard to the Navy's ability to perform any reasonable warranty analysis. As a result the Navy has entered into many contracts unaware of the true financial

implications of the warranty and therefore unsure of the life cycle cost impacts.

3. Naval Air Systems Command

The current NAVAIR warranty policy guidance contained in NAVAIR NOTICE 4855 dated 17 May 1989 (Appendix J) does not accurately translate the intent of the Pyatt memorandum. By establishing the policy to "pursue a no cost warranty" NAVAIR has further exacerbated the problem of trying to develop and administer an effective warranty.

This "no-cost" position when coupled with the latitude given to Contracting Officers to tailor required warranty clauses has resulted in warranties that are not cost-effective. These warranties are typified by significant explicit limitations on financial liabilities, warranty duration and reduced performance levels. Specific examples of these will be presented in the following section on aircraft engine warranties.

C. PROGRAM MANAGEMENT ASSESSMENT

This section presents the findings of the program management assessment. The political nature of the DoD acquisition arena made it necessary to incorporate a review of the current DoD and DoN weapon system warranty programs with respect to compliance with legislative intent. This was done as an attempt to identify and to assess the strengths and weaknesses of the overall program. The review takes into

account the current military policy and directives governing warranties and the procurement review procedures. It takes into consideration the structure of the organization and the training programs for acquisition professionals as well. The findings of the economic analysis were used in conjunction with the policy analysis and the extensive personal interviews conducted with program management personnel to develop this assessment. The program deficiencies noted and recommended changes were discussed with the affected parties and their comments are provided.

1. Congressional Intent

Mandating the use of warranties in weapon system production contracting came at a time when the issue of weapon system procurement was "experiencing one of its periodic episodes of intense concern and policy innovation." (Kuenne,1987) The Congressional intent was to somehow legislate requirements that would address its concerns and attain improved system performance and resource economy. During the McNamara era, the genesis of system analysis, the ever increasing complexity of weapon systems development and acquisition epitomized the obvious need to integrate the procurement process. The systems analyst viewed the entire weapon system procurement process from research and development to manufacture and support as an iterative, integrated process with trade-offs between cost, schedule and

performance. The role of the warranty legislation was then to legislate the consideration of warranties as a tool whose optimal use could be determined by mathematical methodology and contribute to the goal of "producing higher quality systems with minimal life cycle costs."(Kuenne, 1987)

2. Secretary of Defense

The OSD's warranty program management fails to ensure what was intended by Congress. Although the use of weapon system warranties has been credited to a certain extent with producing higher quality systems, they certainly have not been attributed with minimizing life cycle costs (Balaban,1994). It seems as if the focus of the OSD warranty program has been to minimize the impact of the current warranty legislation and ward off any further attempt to impose legislative direction instead of optimizing the effectiveness and efficiency of the warranties used. This is not to say that the DoD has not complied with the law. On the contrary, it must be noted that all weapon system programs reviewed have been found to be in compliance with the basic requirements established by Section 2403. This level of compliance can be credited to the service's internal systemic review process for major weapon systems. So can the lack of efficiency.

The majority of deficiencies noted by the GAO and others in DoD warranty administration can be attributed to the lack of standardized procedures for conducting cost-

effectiveness analysis. Comments in the 800 Panel Report and the wording of the proposed amendment of Section 2403 in the Glenn Bill address the need for these standardized procedures and guidelines. There is also a lack of any systemic review process at the OSD level which reviews the warranty plan as part of the overall acquisition strategy for major weapon systems. Although Program Managers are required to participate in the DAB review process, there is currently no requirement to present the program's warranty plan as part of either the acquisition strategy or the logistic support plan. This would be an ideal opportunity for a warranty plan review. It would significantly enhance the Program Manager's motivation for executing an economically efficient warranty.

In spite of the direction to consider total life cycle costs, contained in both Section 2403 and the FAR/DFARS, the Contracting Officer is often pressured by the Program Manager to do otherwise. This is due primarily to the Program Manager's span of financial control and accountability and, secondarily, to how the system evaluates and rewards the Program Manager's performance. With regard to financial control, it should be understood that weapon system warranties are paid for up front in the production contract out of procurement funding for a requirement that may never materialize. In the case of Navy aircraft engines they are funded out of the Aircraft Procurement Fund, Navy (APN). Although the Program Manager is responsible for funding of

interim logistic support during the initial fleet introduction, all ILS requirements once Navy organic support is established are paid for out of O&MN controlled by AIR-04. The motivation to reduce the up-front warranty cost to the program is obvious. The Program Manager's dilemma is whether to buy quality or quantity. Should the PM decide on quantity, the program will most likely not be responsible for paying the bill for the reduced quality assurance.

Program Managers are evaluated and rewarded by how much money they control, how many weapon systems they buy and how much capability they get for the dollar spent during their tour of duty. This point was made particularly evident on a recent edition of the CBS news program "60 Minutes". They reviewed the case of an Air Force Program Manager working in the Air Force Space Command. Responsible for MILSTAR, a satellite system that tracks ICBMs, the PM was faced with a decision to either upgrade the existing system or continue an ongoing effort to design and develop a new one. When he made the decision to pursue the upgrade, which was determined to be the most cost-effective and would greatly reduce the funding required as well as the budgetary authority under his control, he was relieved of his command after only four months in the job. He was selected for early retirement within the year. Although this is an extreme example, it demonstrates the fact that the evaluation and reward system for Program Managers occasionally runs counter to general expectations (CBS, 1994).

On a lesser level, when a Program Manager is faced with a decision to pay a high premium for a warranty that would hold the contractor accountable for the performance specifications delineated in the production contract or limit the contractor's warranty liability in order to afford the quantity of systems established in the Acquisition Plan, the PM will opt for quantity. This decision, either on the part of the Program Manager or the Contracting Officer, is not made out of ignorance. The Defense Acquisition Workforce Improvement Act (DAWIA), introduced earlier requires both Program Managers and Contracting Officers to receive the necessary education and training on issues such as how to develop and write cost-effective warranties as prerequisites to assuming their positions.

Several of the references used in conjunction with this study were developed specifically for the Program Management Course at the Defense Systems Management College (DSMC) in Ft. Belvoir, Virginia. They are thorough and comprehensive works and represent a significant strength of the OSD warranty program. Although the DoD is fortunate to have such an excellent warranty text, it is not presented in the training syllabus as an integral component of the weapon system acquisition strategy. According to Mr. Bob Fout of MKI, the author of the latest warranty training book used at DSMC "Warranty Guidebook," the warranty training offered at DSMC "appears to be an afterthought." He stated in a personal

interview with the researcher that it was his impression that "they kind of throw you the book on your way out the door. As if to say, 'oh by the way, here is everything you ever wanted to know about warranties'." In fact, the Acquisition Strategy Guide (ASG) used at DSMC was published in July 1984 and does not reflect section 2403 requirements. According to Professor Calvin Brown, the Director of the Program Management Course at DSMC, the school is aware that the ASG is outdated and in need of an update to include the warranty statutes. He indicated the difficulty of addressing the issue stems from the fact that procedures are not standardized and the services do not agree on how to handle warranties. It is also interesting to note that the latest version of the DSMC Program Manager's Notebook, which covers virtually every aspect of acquisition and includes listing of all applicable reference material, does not discuss warranties. This point was made to Professor Brown as well. He indicated that warranties were not included because there was little or no guidance applicable to all Program Managers from OSD and it would be better handled at the service level (Brown, 1994).

The reason, of course, that the OSD has not put forth any guidance is because its current focus is on appealing the current legislation and warding off any future legislative direction regarding DoD acquisition. In several meeting and discussions with OSD personnel from both the Office of Acquisition Reform and the Office of Defense Procurement the

focus and energies of this group were observed to be on supporting initiatives that would reduce the level of Congressional oversight and administrative burdens placed on DoD acquisitions. Ms. Teresa Brooks provided the author with numerous internal DoD memorandums documenting its position in support of a repeal of the current law and its efforts to overturn any legislative effort that did not provide relief from the "cumbersome Congressional notification requirements" established by Section 2403. Needless to say, this does little or nothing to ensure that the warranties being developed and negotiated today are the efficient and effective instruments that Congress intended them to be.

According to Mr. Sal Guli from the Office of the Inspector General of the Department of Defense (DODIG), his organization disagrees with the OSD perspective and program management focus. (Guli, 1994) It was that difference that led to the testimony given before Congress by Mr. Derek Vander Schaaf in March 1994 strongly supporting the retention of the warranty provisions included in the Glenn Bill S.1587. If adopted, Section 2402 of the Bill would require the Secretary of Defense to establish guidelines for warranty waivers, administration and cost-effective analysis.

In conclusion, it can be said that there is an apparent lack of consensus regarding warranties within the DoD. The overall program management focus appears to be on the reduction of Congressional oversight of the procurement

process and not on the effective management of the mandated weapon system warranty requirements.

3. Secretary of the Navy and Chief of Naval Operations

This section of the warranty program management assessment includes aspects from both the Assistant Secretary of the Navy (ASN) and the Chief of Naval Operations (CNO) spheres of influence. As presented earlier, the ASN warranty directive, SECNAVINST 4330.17, tasked the CNO with establishing procedures to ensure that warranties are obtained for weapon systems that meet the thresholds established by higher authority. In response to this tasking, the Deputy Chief for Logistics (N4) included the review of warranties as part of the Logistic Review Group (LRG) audits conducted on all major Navy programs. Although sponsored by N4, the LRG audit board has maintained representation from the program resource sponsors in N8 as well. This is important as many of the logistic issues discussed as part of the LRG, particularly warranties, have significant resource implications.(Fink, 1994)

This is the only comprehensive review procedure established in the Navy which evaluates the extent to which the warranty approach used is compatible with the Integrated Logistic Support Plan (ILSP) and the Acquisition Plan (AP) for the system. It is considered to be a very effective forum for the debate over warranty issues that affect individual

programs. There has been some concern raised over the future effectiveness of the LRG audit because the VCNO is considering a proposal to shift responsibility for convening the review for all programs, including major weapon systems, down to the Systems Command level (Eaton, 1994).

One of the more ineffective aspects of the warranty program was in the area of warranty data collection and analysis. Although the ASN directive calls for the establishment of a system for the collection and analysis of actual warranty claims data, and tasks OPNAV with compiling an annual report, there was no evidence found that this was being done. The lack of interest from the OSD level in addressing the warranty issue from a cost-effectiveness basis has apparently reduced the visibility and demand of any such reporting requirements.

The overall warranty program at the ASN and OPNAV level is in need of review. The review should address deficiencies in the data collection and analysis aspect of the program and stress the importance of a weapon system warranty plan assessment as part of the ILS review process.

4. Naval Air Systems Command

Since the NAVAIR matrix management system structure has been superimposed over the program, the NAVAIR warranty program management problems have become as complex as the organization itself. In accordance with NAVAIRINST 13070.7

(Appendix H), the lead role in warranty programs is assigned to the Assistant Commander for Engineering (AIR-05). Other appropriate responsibilities are assigned to the Assistant Commander for Logistics/Fleet Support (AIR-04), Contracts (AIR-02), Office of Counsel (AIR-00C) and the Comptroller (AIR-08). Within AIR-05, the Product Integrity and Production Engineering Division, AIR-516 headed by Mr. Dick Findley, is assigned responsibility for management of the warranty program. In a phone interview, Mr Bob Tourville, the AIR-516 point of contact, elaborated on the division's high frustration with trying to manage a program for which they had little or no control. Control in this case means not only decision making authority but funding authority as well. In essence, AIR-516 has neither and expressed its candid desire to be relieved of the administrative burden of the overall program management responsibilities (Tourville, 1994).

The Cost Analysis Division (AIR-524) representative Dr. Kang Hu, likewise voiced his frustration with the current system. (Hu, 1994) Although AIR-524 currently has three models available for the computation of the life cycle cost impact of warranties, their effectiveness is limited. In a phone interview Mr Allan Pressman, the Section Head for Propulsion Systems (AIR-52453) explained that the models available for analyzing aircraft engine warranty life cycle cost have varying degrees of complexity and sophistication but they are basically useless without an accurate contractor warranty

price.

One of the more obvious NAVAIR Warranty Program strengths observed by the researcher was Mr. Jim Cleer from the Logistics and Maintenance Policy Division (AIR-411). As the former AIR-04 Warranty Program point of contact, his personal involvement and depth of knowledge was credited by many in the program for correcting a multitude of problems associated with warranty administration within the naval aviation community. During an interview with Mr. Cleer the researcher had the opportunity to discuss the scope of his role as the AIR-04 warranty POC. He explained AIR-04's position on the new "life management" approach to warranties that would reduce the uncertainty associated with the establishing operating life limits for systems beginning production. This approach, which considered the statistical significance of the data available to establish the base operating life lower limits used in a warranty, could significantly enhance the efficiency of warranties being developed for new weapon systems.

Additionally, he spoke about the shared responsibility of screening all NAVAIR procurement requests (PRs). This internal review process was conducted to insure the mandatory warranty requirements were included and, from an AIR-04 perspective, that the clauses used made sense and were compatible with the logistic support systems available. The effectiveness of this process can be argued but, at a minimum,

this procedure at least ensured that cognizant knowledgeable personnel have a chance to review the contracts.

Since the initial interview, Mr. Cleer has been assigned to a new program and division within NAVAIR. With his departure, the warranty program management responsibilities previously covered by AIR-411 were transferred to the Naval Aviation Maintenance Office (NAMO) in Patuxent River, Maryland. The effectiveness of managing a program of this nature with active duty personnel subject to periodic rotation from a remote site is suspect. In a phone interview with the researcher CPT Steve Choate, USMC, the new Warranty Program Manager at NAMO (Code 414-1), described some of the difficulties he had encountered in executing his new responsibility. He added that he had very little activity with the Warranty Program since taking it over and that the responsibility of screening the Prs had remained within NAVAIR.

Another obvious program strength was the inclusion of a warranty review as part of the LRG audit process. AIR-04 chairs the LRG audits for all NAVAIR sponsored systems. Their participation in this process, with or without the OPNAV staff, enables an internal review of the comparability of the warranty plan with the ILSP and AP.

In conclusion, the warranty program within NAVAIR is also in need of review. The issues that should be addressed include: AIR-516's ability to exert control over the execution

of warranties and manage the program, AIR-524's difficulties in providing useful cost analysis, the delegation of AIR-04's role of policy management to NAMO, and the continuation of the LRG audit process. The next chapter discusses the analyses of several aircraft engine warranties.

V. AIRCRAFT ENGINE WARRANTY ANALYSES

A. FOCUS OF ANALYSIS

Originally it was hoped that a detailed post-award aircraft engine warranty cost analysis would be possible despite the Navy's policy on obtaining "no-cost" warranties. Unfortunately, the problems encountered in determining actual warranty costs precluded that endeavor. Therefore, the analysis in this chapter focusses instead on the economic effects of integrating the aircraft engine warranty development and administration into the acquisition strategy. It also looks at the compatibility of the mandated warranties with the function they are intended to perform; that is, to produce higher quality weapon systems with minimum life cycle costs. The analyses take a very critical look at the Navy's use of essential performance requirements (EPRs) for two reasons. The first is to determine the effect of EPRs on the nature or type of warranty. The second is to understand why the government has been generally unsuccessful in its attempts to obtain the anticipated remedy for items included under EPR clauses.

1. Essential Performance Requirements

What exactly is an "essential performance requirement"? The most commonly used EPRs in aircraft engine

production contracts relate to thrust, specific fuel consumption (SFC), shaft horsepower, surge, and life expectancy. It is the derivation and application of specific operational life expectancy requirements that has the greatest potential impact on the warranty's economic efficiency. In fact, in the case of aircraft engines, it can be argued that the inclusion of operating life limits or life expectancy as an "EPR" might not even be appropriate. The arguments made for this point are elaborated upon later in the section that considers the Rolls-Royce F402.

2. Uncertainty, Risk, and Statistical Significance

The uncertainty that stems from the inability of either the contractor or the government to accurately predict what the actual life of any new system will be has the most profound effect on the generation and assumption of risk. To understand why an accurate prediction of the expected operating life of a complex dynamic component like a new engine is not possible, one must consider the statistical significance of the data available to make such an estimate.

The data collected throughout the developmental and operational tests and evaluation (DOT&E) of the engine and aircraft weapon system development is from a small sample of engines. Even in the most thorough engine test and evaluation programs, like the F414 which will accumulate over 10,000 engine operating hours before the engine is incorporated into

an aircraft, the sample will be only 14 engines. Not only is the sample population size small, but no testing program can possibly simulate all aspects of the actual operations of the aircraft and propulsion systems. Even though the data collected from all testing is accurate and complete, the confidence interval for the expected life will be large and hence an accurate estimate of expected life is not possible. It is only from actual historical fleet usage data that accurate operating life estimates can be established. The life management approach to warranties being considered by NAVAIR reflects an understanding of this concept.

3. Program History and System Life Cycle

The chapter first looks at two Rolls-Royce engines. The F405-RR-402 used in the T-45A aircraft and the F402-RR-408 being used in the AV-8B Harrier display some significant differences in the level of warranty integration with the systems life cycle. It was apparent that the Navy personnel assigned to both of these programs viewed Rolls-Royce as being cooperative about warranties. This relationship with the production contractor is one of many important historical considerations to consider in warranty negotiations and will be expanded upon later in this chapter. The importance of this historical relationship is expanded upon in the analyses of the General Electric engines reviewed later in the chapter.

B. ROLLS-ROYCE F405-RR-402

Before getting into any engine warranty analysis, it is important to understand the aircraft acquisition plan and the basics of the acquisition strategy. The T-45A aircraft and the F405 engine are part of the T-45TS Training System. Bought from McDonnell Douglas Aircraft on a sole source contract as a non-developmental item (NDI) and completely supported by contractor logistic support (CLS), the T-45A Goshawk is indeed a unique aircraft program. The NDI concept encourages the military to buy equipment "off-the-shelf" whenever possible. The concept has been embraced by the politicians as yet another way for the DoD to reduce the high costs of developing new weapon systems. The Navy intends to support the F405 engine via CLS for the life of the program as well. This makes the F405 unique from every other engine in the Navy inventory.

The development and procurement of a suitable engine for the Navy's T-45A has been a complex and involved process. Like its predecessor, the British Aerospace Hawk, the T-45A Goshawk, which is manufactured in the U.S. by McDonnell Douglas, was originally powered by the Rolls-Royce F405-RR-400 engine. Designed by Ardour, a prominent French aerospace engineering firm, the original F405-RR-400 (Ardour Mark 861-49) engine performed well on all initial Navy tests except the aircraft carrier landing pattern where it was found to be underpowered. The engine problems were attributed to the increased weight of the Navy's T-45A. The beefed up landing

gear and undercarriage required to support carrier operations added over 1,000 pounds to the design weight of the original Hawk. McDonnell Douglas and Rolls-Royce replaced the -400 with the -401 which had the increased thrust necessary to meet the aircraft operational performance requirements.

Once the engine performance problems were made public, other companies threw their hat in the ring. Since 1987, Garrett has pursued the T-45 program with the hopes of replacing the F405 with its F124. In 1990, the Defense Acquisition Board (DAB) directed the T-45 program to investigate the feasibility of an alternate engine. Accordingly, the Navy announced its intention to conduct a competition for the production aircraft engine based on performance and cost. The candidates that passed source selection criteria were the Rolls-Royce F405-RR-402, an enhanced version of che F405-RR-401, and the Garrett F124. Although Rolls-Royce has the incumbent's advantage, its original life cycle cost estimates were high. They have since taken steps to reduce these costs and increase warranty coverage.

In a recent conversation with the researcher, CDR Wagner, the T-45 APML, indicated that the future of the engine competition is uncertain due to a funding problem caused by Congressionally imposed budgetary reductions (Wagner,1994).

Regardless of what the outcome of the competition may be, the Navy has moved ahead and followed through on its original

intention to "breakout" the engine. "Breakout" simply means that, in contrast to the previous procurement practice where the engine was purchased along with the aircraft under a single contract, the F405-RR-401 is being purchased directly from Rolls-Royce and provided to McDonnell Douglas as Government Furnished Equipment (GFE). It is the differences in the engine warranty coverage contained in the original limited rate initial production (LRIP) contracts with McDonnell Douglas and the breakout contract with Rolls-Royce that are the focal point of this analysis.

It must be noted that whenever the Navy does an engine breakout, the contract administration and overhead costs are paid directly by the Navy. Additionally, the Navy assumes the risks of managing a successful engine program. The risks include those associated with not only the engine performance but the delivery schedule as well. Historically, this has provided the prime contractor an avenue to blame the government for a multitude of aircraft production and performance problems. When the exact nature of a problem cannot be traced, it is relatively easy for the contractor to blame it on the GFE and charge any costs back to the Navy. When an engine is procured by the Prime Contractor as part of the aircraft program, as was the case with F405, any problems that arise in either performance or delivery are for the Prime and its subcontractor to work out. Regardless of the additional risks, the Navy's policy is to breakout the

procurement of engines for production aircraft.

There are 35 T-45A aircraft in the Navy inventory which were produced under development and LRIP contracts. The currently approved and budgeted inventory objective of T-45A is 218 aircraft, the remainder to be produced under production contracts. The inventory objective for engines is expected to be approximately 300. There will be over 90 aircraft delivered with F405-RR-401 engines installed by the time a final engine is chosen and incorporated into the production line. Currently there is no plan to retrofit the final production engines into the earlier aircraft. This decision will force the Navy into the requirement to support two different engines for the same aircraft.

Supporting two different engines produced by the same manufacturer is not a big problem. On the other hand, the cost of supporting two totally different engines manufactured by different companies is a different story. If the final engine chosen is the Rolls-Royce 402, its high degree of commonality with the current 401 engine will certainly make it a less expensive option than trying to support both the Garrett F124 and the F405-RR-401. In the final analysis, it may be too costly to maintain support for two completely different engines, as the CLS for the 401s already in inventory must be continued for the usable life of the engines.

The majority of problems encountered in the T-45A engine acquisition program stem from not competing the engine

contract from the very beginning. Treating the engine as part of an NDI, "off-the-shelf" weapon system package, when design and performance improvements were anticipated was a costly mistake in terms of both dollars and time. A separate competitive engine acquisition plan started at the beginning of the program may have well precluded program delays. It is with this understanding of the T-45 program's history and acquisition strategy that the engine's warranties are evaluated.

The original aircraft LRIP contract was broken down into three Lots. Beginning in FY88 with Lot I, the warranty provided the basic coverage for all three of the elements required under Section 2403 including: conformance with design and manufacturing requirements, freedom from defects in material and workmanship, and conformance to essential performance requirements. The time period covered by the warranty was 290 flight hours or twelve months after acceptance of the aircraft, whichever comes first. Interestingly, the warranty did not delineate any specific EPRs, just the flight hour requirement. The remedies provisions included coverage for redesign and the cost of transportation. There were no financial limitations placed on the warranty.

The coverage provided under the contract for Lots II and III is identical in all respects except for duration. In each successive contract the period of coverage was extended from

290 flight hours or 12 months in Lot I to 360 flight hours or 12 months in Lot II and 480 flight hours or 12 months in Lot III. All three flight hour goals are well within the 60-hour per month upper limit established in the development specification. The average flight hours for aircraft in the Fleet are 30 hours per month. There were no limitations or exceptions associated with the increase in flight hour coverage. The cost of the warranty was not separately negotiated so there is no warranty price data available. The warranty can be clearly categorized as an assurance warranty. This is because of the period of coverage, the level of contractor control and the minimal cost differential between providing remedies in the pre- and post-acceptance period.

The simplicity of this warranty is its strength. Additionally, the fact that both the aircraft and the engine were under CLS gives the contractor the maximum control possible over obtaining the performance goals established by the contract. This warranty is an excellent candidate for the Navy's "no-cost" warranty. Additionally, it should be noted that the redesign effort required to upgrade the 400 to the 401 configuration was paid for by RDT&E funding under the aircraft development contract.

The warranty included in the FY-94 GFE breakout contract of the F405-RR-401 is "a horse of a different color". The period of coverage for both conformance to design and manufacturing requirements, and defects in material and

workmanship is 36 months or 1000 flight hours after acceptance, whichever occurs first, with the exception of cold section life-limited parts which are covered for 2000 flight hours after acceptance.

The use of EPRs was greatly increased. They include the following requirements:

1. Maximum allowable thrust deterioration will be no more than 6.5% for 1000 flight hours after acceptance.
2. Maximum allowable specific fuel consumption deterioration will be no more than 5.5% for 1000 flight hours after acceptance.
3. Operation without surge for 1000 flight hours or 36 months, whichever occurs first.

The warranty then goes on to individually list each major hot section component and provide life limit lower bounds in terms of hours, cycles and counts and specifies the end of their warranty period to be when the first of any of theses operating life specifications is obtained. As if this were not enough, the warranty contains a final clause that requires the engine to meet the specification requirements not delineated in the warranty for a period of 48 months of operation or 2500 flight hours, whichever is longer, after final acceptance. At an average engine utilization rate of 30 hours per month this period would be approximately seven years.

With these increased periods of coverage it was not surprising to see changes in the terms of the remedies offered and the establishment of specific financial liabilities. The

first to go was the shipping and handling. The contractor's responsibility was reduced to furnishing materials to the government at the original point of delivery or the contractor's plant. This is significant when considering the plant is in the United Kingdom.

The liability limitations are as complex as the clauses themselves. Basically, Rolls-Royce established a limit of 2 million pounds sterling for redesign and qualification if the government buys 20 engines. This financial limit allows for a pro-rated adjustment up or down based on the number of engines actually procured under the contract. The cost are specifically to be considered exclusive of profit and if the costs exceed the limit they will be shared equally by the U.S. Government and the contractor.

The warranty has a distinctively different approach from the one used in the aircraft LRIP contract. In this warranty there was a concerted effort on the part of the government to extend the period of coverage significantly into the post-acceptance period. The technical nature of such a contract warranty is better suited for a program like the T-45A which is completely supported by contractor personnel than for a combat aircraft engine, as it would be difficult to administer by active duty personnel.

The fact that the contractor sought relief from the virtually unlimited risk and corporate liability indicates that the nature and economic characteristics of the FY94

engine breakout contract warranty was a significant change from its predecessor. The EPR clauses found in this new contract warranty can be accurately depicted as an insurance warranty.

C. ROLLS-ROYCE F402-RR-408

As stated earlier, the problems experienced with the procurement and support of the Rolls-Royce F402-RR-408 Pegasus engine, used in the Marine Corps AV-8B Harrier aircraft, indicate that the use of arbitrary operating life EPR warranties in engine production contracts might be inappropriate. Contracted for in May of 1988, the 408 is the latest of three Rolls-Royce engines to be used in the AV-8B Harrier. Preceded by the F402-RR-406 and the 406A, the 408 has been plagued by problems, including some serious enough to shut down the production line. One of the more significant problems experienced has been with the inability to attain the warranted operating life of the engine hot section. According to Jim Carrol, the engine Program Manager in AIR-536, Rolls-Royce is working very hard to deliver the product it promised. (Carrol, 1994)

One of the promises Rolls-Royce made was that the 408 engine would have a 1000-hour hot section. The problem is that they are only getting 600 hours out of the HP Turbine blades. Right now Rolls-Royce is expending tremendous resources in an effort to correct the problems. Fortunately for the Navy, the

work is being covered under the warranty. When asked by the researcher what kind of impact this "severe" problem was imposing on aircraft availability, the answer given by the Steve Clark, the engine APML from AIR-410, was "None!" (Clark, 1994) This was difficult to understand. How could this be? The life limits of the new 408 engine hot section were critical enough to be considered an "essential performance requirement". Why then was there no impact on the aircraft availability? This question led to several interesting discussions with program representatives throughout NAVAIR.

It was explained to the researcher that the Navy and Marine Corps had originally gone to Rolls-Royce requesting that they do something to improve upon the thrust of the original 406 and 406A engines. The operator's wanted an engine with more thrust. After careful consideration, Rolls-Royce indicated that although it could not achieve the level of thrust improvements desired with its new engine, it could get significantly better life from its hot section. What ensued was a life-cycle cost analysis to justify the procurement of the 408 based upon the improved reliability of the turbine.

The increase in life expectancy and reduced life cycle costs were used as marketing tools by Rolls-Royce. The entire engine world seems driven to prove that it is possible to reduce the life cycle cost of an engine by squeezing more life out of the hot section. The Navy program management folks basically said, "Put your money where your mouth is and we got

ourselves a deal". Rolls-Royce answered the call and signed up to a contract with a warranty that was supposed to "hold their feet to the fire". (Carrol, 1994)

The F402-RR-408 engine has been unable to achieve the 1000 hour hot section operating life promised in its warranty. The current average hot section operating time before repair is approximately 600 to 700 hours. So one would expect this significantly reduced operating life to eventually affect aircraft availability. Fortunately for the Harrier program office, the ILSP was developed to support the 406 which was a 500-hour engine. Accordingly, it is difficult to understand how the Navy could require Rolls-Royce to stand behind this operating life performance specification estimate when it is obviously not "essential" to the operational availability of the aircraft.

The actual terms of the 408 warranty include all the clauses required by Section 2403. The warranty requires the engine to be free from defects in material and workmanship, and to conform to design and manufacturing requirements for 300 flight hours or 12 months after the first flight of the engine, or 3 years after acceptance, whichever comes first.

The EPRs include meeting requirements established for individual engine components. These components listed in the warranty included specific operating life limits calculated in engine flight hours, Engine Monitoring System (EMS) life counts or cycles as well as calendar dates:

1. Thrust values and specific fuel consumption specification requirements for 1000 engine flight hours, equivalent engine EMS life counts or six (6) years after acceptance, whichever comes first.

2. Operating periods for any hot section part of 1000 engine flight hours, equivalent EMS life counts or six (6) years, whichever comes first.

3. Operating periods for any cold section part of 2000 engine flight hours, or EMS cycles, or ten (10) years after acceptance.

4. Operation free of non-recoverable or recoverable surge for six years after acceptance or 1000 flight hours, whichever occurs first.

The rights and remedies offered are standard and include provisions for redesign. They establish specific cash limits for liability associated the timely return of repaired parts and the incorporation of redesign parts. Exceptions and conditions are established in which the government will bear the cost of transportation to and from the contractor's plant and caps the financial liability of meeting any warranty costs at 10.5 million pounds sterling. Should the costs exceed that, they will be equally shared between the government and the contractor.

This warranty, much like the one negotiated for the F405 breakout, significantly extends the coverage into the post-acceptance period. This aspect, coupled with the limited control of the contractor to ensure the specifications are met, significantly shifts the risks to the contractor and is therefore representative of an insurance warranty.

As an interesting side note, the program management personnel interviewed by the researcher are fully aware of the financial limitations associated with warranty costs. They expressed some concern that they might be getting a bill to cover their portion of the cost beyond the 10.5 million pounds for which they are liable. It was evident that they were not fully aware of the actual current costs charged to the warranty account and it appeared as if they were afraid to ask. Again it can be seen that any attempt to shift the risk to the contractor is bound to be met by requests for limitations or exceptions. If there were not any limitations, the procurement cost would have to include the exorbitant cost of such a warranty. The request to establish liability limits are ready indicators that the specification parameters stipulated have forced the nature of the warranty to change and therefore exceed the realm of a "no-cost" warranty.

The next three sections look at engine products produced by General Electric. As stated earlier in this chapter, the relationship a company shares with the government is an important aspect in the negotiation of a warranty. This is made evident in the differences in the warranties.

D. GENERAL ELECTRIC F404-GE-400/402

This section looks at the historical problems associated with the General Electric F404-GE-400 used in the McDonnell Douglas Hornet, F/A-18A/B & C/D. The F404 program began in

1975. General Electric began production of the F404 in 1980 and, by the end of March 1990, had shipped over 1,900 engines. The F404 enhanced performance engine has been designated as the F404-GE-402. From the beginning the approach use for the F404 development was different and emphasized operational suitability and reliability, as well as performance and weight. The use of cost plus incentive fee development contracts for reliability and maintainability and an alternate or second-source contractor for production were the type of initiatives embraced by the program to get the best possible product at a given cost.

With regard to warranty use, the early contracts for Lots I through III provided no explicit warranty coverage. The warranty coverage for Lots IV through IX provided for basic materials and workmanship, and design and manufacturing, from the time of acceptance until the engine was installed in an aircraft (McLaughlin, 1994). Beginning in 1985 with Lots X and XI, the Navy adopted a more comprehensive warranty that met the newly mandated weapon system warranty requirements. So the condition here is one in which the engine development statement of work (SOW) was written before the use of weapon system warranties became mandatory. This condition is considered to have a significant impact on the final negotiated cost of a warranty (Balaban, 1985).

1. F404-GE-400 Lot XI

The warranty for the Lot XI contract included all the clauses required by Section 2403, including clauses covering EPRs which were extremely complex. The warranty included requirements to meet the following specifications:

1. Delivered free from defects in materials and workmanship, and conform to design and manufacturing requirements for a period of 200 flight hours after acceptance.

2. Maximum deterioration limits on thrust, specific fuel consumption, acceleration/deceleration as well as meeting specifications for starting altitude and time to stabilized idle thrust for a period of 100 engine flight hours, 300 operating hours or two years, whichever occurs first.

3. Operating period for any hot section part requiring repair or replacement of six years or 75% of the design specification expressed in terms of Equivalent Full Thermal Cycle (EFTC). EFTC equates to a change of engine power from idle to intermediate or above and back to idle as mathematically determined in the Engine Monitoring System (EMS).

4. Operating period for any cold section part for ten years or 75 % of the design specification for operating life expressed in terms of Equivalent Low Cycle Fatigue Cycle (ELCFC). ELCFC is an accumulation of engine power changes calculated as follows:

ELCFC = FLCFC - (PLCFC - FLCFC) (KB) where;

- FLCFC = Full Low Cycle Fatigue Cycle = a change in engine power from off to intermediate or above and back to off.
- PLCFC = Partial Low Cycle Fatigue Cycle = a change in engine power from 12,800 rpm to 15,500 rpm and back to 12,800 rpm; and
- KB = Damage factor defined differently for each part listed. The KB factor listed for the Stage 1 Fan Disk is 0.045.

5. Protection against surge problems for 1500 engine flight hours or 5 years, which ever comes first.

The rights and remedies portions of the warranty were standard and provide all engineering and hardware necessary to complete the redesign, qualification testing, and bench testing for repeated warranty breaches for all EPRs. Additional provisions require the contractor to provide all parts and labor to incorporate the redesign for any part that has a life of half of what is specified and any surge breach.

In addition to the normal provisions found in the Exceptions and Conditions portion of the warranty regarding proper maintenance and operations, negligent installation by non-contractor personnel, substitution of non-contractor parts, Battle Damage and FOD, it requires the government to bear the cost of transportation to and from the contractor's plant. The government is also required to fund and conduct any full scale development and qualification testing and provide the engines necessary for the testing. Lastly, stipulations concerning statistical life calculations exclude parts delivered by Pratt and Whitney or suppliers other than General Electric.

The last provision covered in this analysis of NAVAIR and GE's first engine warranty to comply with the newly mandated coverage is the most indicative of its change in nature. General Electric's desire to protect itself from the

uncertainty and risk associated with this warranty was clearly expressed in the Limitation of Liability. It specified that "the limitation of liability for all remedies contemplated by paragraphs B.3 and B.4 shall be $8,500,000.00" Paragraphs B.3 and B.4 are the provisions concerning life limits for hot and cold section components. Unlike the Rolls-Royce contracts that offer a cost sharing provision for all limits on EPRs, this warranty firmly and absolutely limited General Electric's financial liability over operating life EPRs.

This warranty serves as an early and excellent example of the economic effects of requiring the contractor to guarantee the operating life of any engine component significantly into the post-acceptance period. Specifications given in terms of ELCFCs and EFTCs and whichever comes first are clear attempts to limit the period of liability. Further limitations are added which require the contractor to pay for parts and labor of any redesign requirement only if the achieved life is less than half of what is specified in the warranty which is set at 75% of the original design specification. In essence, the redesign warranty is applicable to only 37.5% of the design specification. This is indicative of the contractor's intent to charge the government for any redesign efforts involved with components that achieve greater than 37.5% of operating life design specification. The final stroke is the financial cap established in the Limit of Liability paragraph. These contractual efforts clearly

indicate the contractor's awareness of the economic effects of uncertainty and risk associated with operating life EPRs and are indicative of an insurance warranty.

2. F404-GE-400 Lot XII

In the wake of the performance problems experienced in the Fleet with the F404 and the necessary reduction in the operating life limits of numerous components the terms and conditions of the warranty written for the Lot XII contract make for an interesting comparison. The provisions for delivery free from defects in material and workmanship, and conformance to design and manufacturing requirements were expanded to include all specification requirements of the contract for a period of 300 engine operating hours. Engine operating hours represent all hours of operation both before and after acceptance. This warranty period is therefore equivalent to an operating period of less than 10 months.

The way the EPRs are specified indicates an attempt to limit the contractor's liability as well:

1. Thrust deterioration specifications were relaxed from within 98 and 97% of specified values in Lot XI to a not to exceed deterioration of 5%. The operating period changed from 100 engine flight hours, 300 engine operating hours or two years, to 625 operating hours.

2. Specific Fuel Consumption (SFC) deterioration limits were changed to a not to exceed value of 5% of specification for 625 operating hours as well.

3. Hot section life limits introduced the use of the B10

Weibull life distribution for the hot section as a determining factor of contractual compliance with the EFTC values specified in the warranty which are 75% of design specification. B10 Life is defined in later GE contracts as: Rated life, the time by which 10% of the specified parts will have failed.

4. Cold section life limits require the use of the B0.1 Weibull distribution for structural life be applied to the ELCF values specified in the warranty which are 75% of design specification. B0.1 Life is defined in later GE contracts as: Rated life, the time by which 0.1% of the specified parts will have failed.

5. The final stipulation limits the contractor's exposure to risk by requiring that they be notified in the event of any warranty breach of hot section operating life within five years and any cold section operating life within ten years after the last engine/module tendered for delivery.

The addition of the repair of all "secondary damage" to the remedies covered under material and workmanship, design and manufacturing was considered a big plus on the part of the government. The "secondary damage" clause gave the government an avenue to collect against "damage to parts within the engine caused by the rupture of a part which is incorporated in that engine or by an engine section malfunction." The term as defined in the warranty specifically excludes "damage to other engine or any other property external to the instant engine or any consequential damages."

With regards to remedies of EPR breaches which require redesign, the contractor agrees to provide only the hardware necessary to eliminate the cause of the breach for each engine which has accrued at least 300 operating hours since acceptance and stipulates that the government will fund any

design and development work necessary for qualification of a modification. It also requires that if, after correction action is taken, it is determined that a breach did not occur, then the government will compensate the contractor to pay for any work completed in the effort.

With all of the technical specifications negotiated and duration periods defined, General Electric closes the door on its exposure to unlimited risk in the Limitation of Liability paragraph which stipulates that "The contractor's liability for remedies reported under paragraph B.2 (all EPRs) shall not be greater than 10% of the total contract price". It is evident in the wording of this warranty that the contractor has taken further steps aimed at reducing its risk and potential liability associated specifically with EPRs which significantly extend the period of coverage into the post-acceptance period. The obvious lack of concern for the other warranty clauses confirms that they function as an assurance warranty. Conversely, the extensive efforts to technically and contractually limit the terms of the EPRs is indicative of an insurance warranty.

E. GENERAL ELECTRIC F110-GE-400

The General Electric F110-GE-400 is an Air Force managed engine being used in the Navy F-14D aircraft. The original Air Force production contract was signed in December 1984 before Congress enacted either Section 794 or 2403. According to the

IDA Paper, "it provides a good example of one of the more sophisticated warranties from the pre-mandated era". (Kuenne, 1987) In a follow-on contract in 1986, the Navy procured 292 engines from General Electric and has procured an additional 60 engines in a separate buy. According to Mr. Karl Matson, the GE F110 Program Manager, the procurement price of the F110 is approximately $3.44 million per copy. (Matson, 1994) Although similar in many respects to the original Air Force contract warranty, the economic characteristics of the Navy's first F110 contract warranty are distinctly different. The compatibility of this warranty with the Navy's F110 engine acquisition strategy and the F-14D program is evaluated on its own merit.

The Navy F110-GE-400 contract warranty has several unique characteristics. First, although negotiated in the post-mandated era, there is no specific design and manufacturing clause and second, the performance specifications listed in the warranty are not referred to as EPRs. The warranty specifies the operating life limits in terms of Total Accumulated Cycles (TAC). TAC= LCFC + FTC/4 + CIC/40. FTC and LCFC are the same as previously defined above in the F404 discussion. Cruise Intermediate Cruise (CIC) is the equivalent of a cycle from cruise to intermediate and back to cruise power settings as measured by the Engine Monitoring System (EMS). The warranty does provide for the following:

1. Freedom from defects in material and workmanship, conformance to the drawings in the current parts list, and any condition rendering an engine unusable or unserviceable or causing it to operate in other than within maintenance limits, for a period of two years or 250 engine flight hours or 290 engine operating hours, whichever comes first.

2. Thrust, SFC, afterburner light-off, acceleration and deceleration, and altitude starting engine stabilization as specified in the engine specification for a period of 250 flight hours or 290 engine operating hours or two years from acceptance, whichever comes first.

3. Hot section parts operating without failure equiring repair or replacement for a period of five y s or 3000 TAC.

4. Cold section parts operating without requiring repair for five years or 3000 TAC; without experiencing failure or requiring replacement for eight years or 6000 TAC.

5. Operation surge free for five years or 3000 TAC after acceptance which ever comes first.

The remedies provide for breaches of warranty items listed in paragraph 1. above were limited to just providing the replacement parts required to eliminate the cause of the breach. For the several performance specifications listed in paragraph 2. above, the remedies provide full engineering and hardware necessary to complete the redesign, development and qualification testing, parts and labor as well technical data revision for repeated breaches which have a significant adverse impact on the operability or readiness and are caused by design deficiency.

The hot section warranty remedies include replacement parts to eliminate the breach, engineering and redesign hardware, as well as development and qualification testing

support for parts having a B10 life without repair of less than 3000 TAC. In addition, parts and labor and technical data are included for any B10 life of 1500 TAC or less.

The cold section warranty remedies are similar in all respects to the hot section except it uses the B0.1 life determination and the extended life limits associated with the cold section specifications. The remedies for the surge warranty are the same as those governing the other paragraph 2. performance specifications. It specifies that all development and qualification testing for any redesign will be funded or conducted by the government and that the government will provide the necessary engines.

The remaining paragraphs include the standard exceptions and conditions found in most engine warranties but the limitations of liability are very explicit. The warranty states that the contractor's liability for any remedy shall be no greater than the sum of the value calculated from the following equations where L is the limit of liability and N is the number of engines procured under the terms of the contract:

1. For the aggregate of paragraph 1. remedies:
   L = (N/720 x $61.1M)
2. For the aggregate of paragraph 2. remedies:
   L = (N/720 x $48M)
3. For the aggregate of paragraph 3., 4., and 5. remedies:
   L = (N/720 x $45M)

Even this early contractual attempt to extend the

period of warranty into the post-acceptance period was met with a very calculated limit of financial liability negotiated in behalf of the contractor. This is once again indicative of an insurance warranty.

F. GENERAL ELECTRIC F414-GE-400

With the historical background of engine warranties provided thus far, the analysis now focuses on the warranty approaches being considered for use with the General Electric F414-GE-400 engine now in development for use in the new McDonnell Douglas F/A-18 E/F. This analysis was based on data and material obtained during phone and personal on-site interviews conducted with program management representatives from both the Navy and General Electric Aircraft Engines (GEAE).

The F414 development effort through Engineering and Manufacturing Development (E&MD) is estimated to cost over $700 million. What began in 1987 with the first series of optimization studies was a program "structured to minimize development risk". The Program Objectives and Milestones (POA&M) chart is included as Figure 1. There is an obvious positive attitude towards the program throughout the Navy F414 staff. With aircraft production not scheduled to begin in 2001, the program management from AIR-536 believe that there is ample time and testing in the engine's development schedule to ensure success. Mr. Dan Squire, of AIR-536, informed the

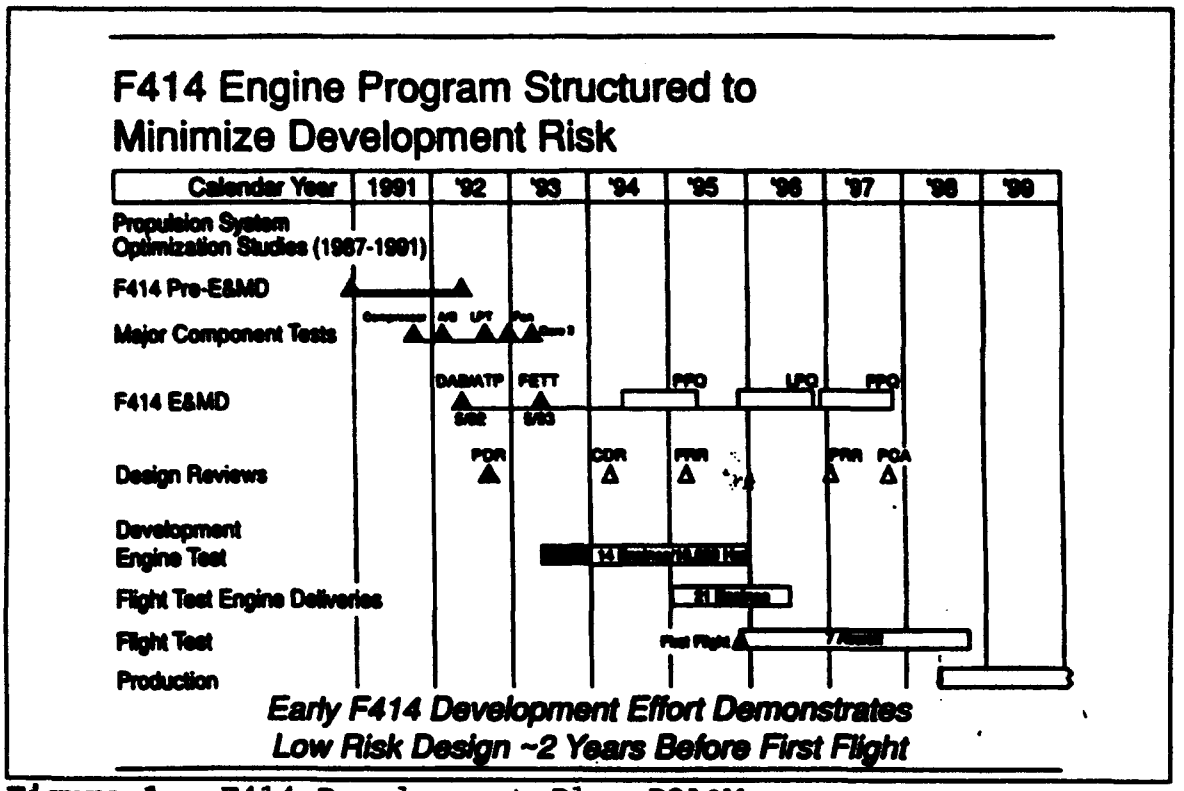

Figure 1. F414 Development Plan POA&M

researcher that there will be over 10,000 hours of testing conducted under the development contract prior to the first aircraft test flight, scheduled for late in calendar year 1995. When queried with regards to the essential performance requirements criteria expected in the production contract, Mr. Squire indicated that the Navy was expecting to pursue thrust retention and specific fuel consumption within 2% of specification for 2000 flight hours. He added that the Navy had contracted with GEAE to develop and build an engine with a 2000-hour hot section and a 4000-hour cold section. He explained that the longer the period between required removal, the cheaper the life cycle cost would be. When asked by the

researcher if these specifications were realistic and obtainable given the history of life limit reductions faced by the F404 program, he indicated that he believed they were. (Squire, 1994)

The rational for this optimism was the program's use of Damage Tolerant Design (DTD) requirements. The Low Cycle Fatigue (LCF) criteria previously used assumed the components were all defect free. The new DTD criteria accounts for allowable defects in its determination and, in essence, "beefs up" the reliability of the engine. This, of course, comes at some cost, as there is always a trade off with every design decision. In this case it came in the form of added weight. According to Mr. Kevin Field, the GE F414 Program Manager, approximately 42 additional pounds were attributed to the DTD requirement (Field, 1994). He added that even though GE had not received any relief from the maximum weight specification of the engine, they were able to make up the difference in other areas.

The estimated per unit cost of the F414 is $2.3 million based on the 250th unit. (Field, 1994). The proposed warranty has provisions for the listing of selected EPRs as a separate attachment to the basic warranty. The cost and efficiency of the warranty will depend on which EPRs are finally chosen and how they are applied. As has been the case in the warranties reviewed, the operating life EPRs are expected to have the most significant impact on the warranty cost and efficiency.

The warranty approach being considered for the F414 is an adaption of the life management approach discussed earlier. A separate F414 Life Management Plan is intended to be a an attachment to the warranty as well. This approach adopts a low risk, easily obtainable warranted service life for the first production Lot based on the proven engine performance to date and the statistical significance of the data available through the development phase (McLaughlin, 1994). The program then requires the contractor to upgrade the warranted service life coverage for the entire inventory of previously accepted engines to the most recently negotiated service life identified as an EPR in the warranty of each subsequent Lot.

This approach has some real merit in the way that it minimizes the uncertainty associated with early predictions of service life. The potential contractor liability is significantly reduced and the government only asks the contractor to sign up to incremental increases in service life based on achieved service life. This changes the situation from one of uncertainty to one of definable risk. Although this is a step in the right direction, there might still be cause for concern. The economic nature of the warranty is still subject to change if the clauses are worded in such a way as to create an insurance function.

The warranty approach proposed for the F414 also intends to include the use of some incentive fee for criteria that are yet to be determined. It includes provisions for secondary

damage, analysis of defects and failures, redesign, and splits the shipping costs; contractor in CONUS, government to CONUS.

The proposed warranty approach does take into account the majority of "lessons learned" regarding aircraft engine warranties. One notable exception was in the area of determining EPRs early in the E&MD phase. In a recent conversation with Mr. Kevin Field, the GEAE F414 Navy Program Integrator, GE still did not have a definitized list of EPRs from the Navy. This delay precludes any efforts the contractor may undertake during development to reduce the risk associated with the specified performance criteria. Additionally, he indicated that there was no service life listed in the production specification. If this is true, it could pose a serious problem when determining EPRs.

As explained by Mr. Dave Pauling, AIR-5362 Branch Head, the Navy has experienced problems in the past when performance specifications, which were delineated in Section 3 (Requirements) of the development contract, are not included the Section 3 of production contract specification. It had been almost common practice for the contractor to build production engines to a qualified parts list developed as a result of qualification during development. The real problem with working to a parts list surfaced when the Navy began experiencing engine performance levels below the design specification and pursued resolution via the warranty. They thought they had contracted for an engine that met the design

specification when, in fact, the parts list in the production contract took precedence over the performance specification given during development. This has resulted in an initiative to ensure the design specification is listed in Section 3 of the production contract as well. (Pauling, 1994) This is critical to the success of the Navy's desire to effectively contract for EPRs because, according to the NAVAIR Office of Counsel, the Navy cannot legally apply an EPR specification which is not called out in Section 3 of the production contract (Townsend, 1994).

Although the F414 represents one of the most comprehensive warranty approaches ever to be developed, there is still a potential for significant inefficiencies based on the late determination of EPRs, duration of operational life coverage, required specifications not in the production contract, and limitations of liability established at the final stage of the contract negotiation. The need to have a warranty fully integrated with the acquisition strategy is clear.

G. CONCLUSIONS

The preceding aircraft engine warranty analyses focussed on the economic characteristics of warranties and the specific clauses or approaches used in the engine production contracts. As a consequence the following conclusions can be stated.

- All the warranties reviewed, with the exception of the F110, complied with the three basic elements of the

required warranties; defects in materials and workmanship, conformance to design and manufacturing requirements, and conformance to EPRs.

- The compatibility of the warranties with the acquisition strategy and logistics support plan for the aircraft and engines varied.
- The lack of adequate warranty cost information has resulted in the program abandoning the use of engine warranty life cycle cost analysis models.
- There were more significant incompatibilities discovered in the warranties written shortly after their use became mandated.
- The greatest amount of uncertainty and risk in the warranties is in regards to EPRs.
- The greatest amount of uncertainty and risk associated with EPRs is in the use operating life limits.
- Contractors will always attempt to protect themselves contractually against EPRs which have a high degree of uncertainty and expose the contractor to risk.
- The use of the life management approach will reduce the uncertainty associated with the use of operating life EPRs.

The Navy's use of warranty to achieve the desired higher quality systems at lower life cycle cost can certainly be argued against given the historical problem associated with operating life EPRs in particular. It is a simple case of "you get what you paid for". It is truly unfortunate that the Navy does not know what it paid for. Because of this fact, a post-award life cycle cost analysis using the current models designed for that purpose was impossible. The lack of actual warranty cost data did not undermine the above analysis, however. There were sufficient, significant indicators found

in the language and terms of the actual engine contracts reviewed to support the findings.

The cost-effectiveness problems associated with aircraft engines can only be partially attributed to the nature of uncertainty and the government's desire to insure against it. These problems are be exacerbated by many other factors including the belief of some of the managers in the engine program "that an engine that lasts longer, costs less". On that note, Chapter VI presents a set of guidelines to assist engine Program Managers in the development of warranties integrated into an engine acquisition strategy.

VI. ENGINE WARRANTY INTEGRATION GUIDELINES

This chapter builds on the findings of the previous chapters to establish a set of guidelines that can be used by the aircraft engine systems Program Managers to develop future warranties. It attempts to synthesize the information derived from economic analysis of the current warranty requirements mandated by law, regulations and current policies, the effectiveness of actual aircraft engine warranties used in the past, and the current program management strengths and weaknesses. The goal of the guidelines is to assist the program managers in evaluating the effectiveness of various warranty approaches being considered and the successful integration of warranties into an aircraft engine's acquisition strategy.

A. BACKGROUND

Although, the concept of integrating warranties into a weapon system's acquisition strategy is not new, it is particularly difficult to accomplish successfully. According to the DSMC Acquisition Strategy Guide (ASG), warranties were addressed as one of the "Strategic Issues and Alternatives" because of "recent emphasis by Congress" (Nelson, 1984). The ASG encourages Program Managers to consider warranties as an applicable element in developing both the design strategy and

business strategy for their weapon systems. The ASG failed, however, to tie the importance of warranties back to the strategic element entitled "program objectives, constraints, and priorities". It is in this element, which is comprised of sub-elements for technical performance, operational capability, production cost and life cycle cost, where warranties have the most effect.

Although the ASG does not include any of the Section 2403 requirements, as it was published prior to the federal mandate of weapon system, it is still being used at in the Program Management Course (PMC) at DSMC. Additionally, it does not cover any of the Navy warranty policy guidance. In practice, even when following the early guidance provided by the ASG and the current guidance presented in the FAR and DFARS, the warranty procurement cost and system life cycle cost associated with the warranty clauses required by Section 2403 can vary depending upon approach. Therefore the potential benefits that would result from a standardized set of guidelines on the efficient use of resources are significant.

B. WARRANTY AND SYSTEM LIFE CYCLE

The first question that should be asked by the PM is "when is the best time to address warranties in the weapon system life cycle?". The answer to this, of course is, "Up front, and early!". The importance of considering warranties as an integral part of the engine acquisition strategy from the

onset cannot be understated. The original DSMC "Warranty Handbook" (Balaban, 1986), and the new "Warranty Guidebook" (Fout, 1992) both confirm this point. According to the "Warranty Guidebook" the Program Manager is responsible for planing, coordinating and integrating the warranty "as early as humanly possible." It goes on to state "The warranty must be consistent and compatible with the operational and logistical concepts". In general, the guidance in the current DSMC "Warranty Guidebook" provides an excellent foundation for the successful integration of the Navy's aircraft engine warranties into the acquisition strategy.

The engine Program Manager needs to include warranty considerations during the Concept Exploration and Definition Phase studies conducted on the engine system performance, reliability and life cycle cost estimates. The PM must also understand that any decisions made on the engine configuration and design can affect both the warranty approach and the future ILS of the system. This consideration of warranties early in the engine system life cycle is seen as the first step towards the successful integration the aircraft engine warranty into an acquisition strategy.

The next important step in the successful integration of the warranty is the development of the initial warranty provisions and identification of the EPRs expected to be applied in the engine production contract. This should be accomplished during the Demonstration and Validation (DEMVAL)

phase and completed prior to the Milestone II review. The EPRs selected must be consistent with the technical specifications and operational characteristics delineated in the Operation Requirements Document (ORD) and support the Mission Need Statement (MNS) of the aircraft.

Although a formal a review of the engine warranty program is not required as part of any of the formal DAB Milestone reviews, if applicable, the sooner the contractor is aware of the specifications and terms expected to be used in the engine production warranty, the sooner they can begin to work towards reducing its risk of not achieving the specifications desired. Another reason why it is so critical to identify EPRs during DEMVAL is so that any test requirements required to implement the warranty can be included in the Test and Evaluation Master Plan (TEMP). The TEMP, which is also developed during DEMVAL, is reviewed as part of the Milestone II review process and as such is formalized prior to proceeding into the Engineering and Manufacturing Development (E&MD) Phase.

During E&MD is "where the rubber meets the road". This is where the preliminary data is collected and analyzed. During this phase the warranty feasibility assessment should be completed and the final provisions refined for inclusion in the production contract request for proposal (RFP). This is obviously not the time to just be beginning to think about the basic warranty approach.

C. HISTORICAL CONSIDERATIONS

Another important facet for the PM to consider in developing a warranty is the engine system's development and procurement history. Ignoring or omitting certain historical aspects from consideration can significantly affect the cost and efficiency of the warranty and are therefore seen as a key element in the integration of a warranty into a successful acquisition strategy. The historical considerations made can encompass many aspects, such as the development contract start date, the use of alternate source contractors, changes in the warranty terms, conditions and specifications, the technological advancements and the contractor's past performance and reputation. These particular aspects will be addressed below because of their significance and potential impact on the efficiency and effectiveness of the warranty under development.

1. Historical Factors' Influence On Warranty Cost

One of the first historical aspects that should be considered by the PM is when the Engineering and Manufacturing Development contract was written. If it was written prior to 1 January 1985, when the federal mandate to include warranties on all major weapon system production contracts went into effect, it can have a profound effect on the contractor's exposure to risk. The significance of this can be seen in the "Historical Factors' in Warranty Cost" chart presented as

Table I. Adapted by the researcher from a matrix developed by Mr. Balaban to assess the validity of the Navy's "no-cost" assumption (Balaban, 1985), the chart is based on three important factors related to a weapon system's procurement history. The three factors used are:

1. When the development contract was written.
2. Whether the production contractor is the same as the development contractor.
3. The terms and specifications used in the production contract warranty as compared to those used in the development contract statement of work (SOW).

Table I. HISTORICAL FACTORS' INFLUENCE ON WARRANTY COST

Warranty Cost				
	Post-1985 EMD Start		Pre-1985 EMD Start	
	PK = DK	PK not DK	PK = DK	PK not DK
W<=DSOW	Low	Medium	Medium	Medium to High
W>=DSOW	Medium to High	High	High	High to Very High

LEGEND

EMD	Engineering and Manufacturing Development
PK	Production Contractor
DK	Development Contractor
W	Warranty Terms and Conditions
DSOW	Development Contract Statement of Work

According to Mr. Balaban, the entries used in his matrix were subjectively determined but represented a reasonable

assessment of the acquisition environment.

The first historical factor focusses on whether the development contractor was aware the engine would be subject to the federally mandated production contract warranties. If the development contract was written after January 1, 1985, then the contractor knew the engine was subject to the Section 2403 warranty requirements. If the development contractor was considered likely to get the production contract as well, then there would be an incentive for them to design the equipment so that the exposure to warranty risks were minimal. Additionally, if the specifications and EPRs are established prior to entering E&MD, whatever work was required to meet the future warranty challenge could be priced into the development contract.

The second factor takes into consideration that the contractor who develops a weapon system is not always the one and only contractor to get a production contract. With the emphasis on competition in DoD acquisition, many systems today are produced by alternate source contractors. Aircraft engines are no exception. The DFARS only allows the exemption of alternate source contractors from essential performance requirements until after the first ten percent of the anticipated total production quantity has been produced.

In essence, a situation is created where one contractor is actually being required to guarantee the engines they produce meet the performance and design specifications

developed by another. If the alternate source contractor is required to meet the same warranty requirements, including redesign as a remedy if required, then they are exposed to greater risks than the risks to the contractor who was both the developer and producer. Since risks equate to costs, it can be expected that the warranty cost for a alternate source contractor will be higher.

The last factor considered are the terms, conditions and specifications of the warranty. If the production contract warranty terms and conditions are new to the contractor or the specifications used are more stringent than those found in the development contract's SOW specifications, then the contractor's exposure to risk is greater. This applies to specifications used in conjunction with all the required warranty clauses: conformance to the design and manufacturing requirements, freedom from defects in materials and workmanship, and essential performance requirements (EPRs) as well.

From Table I then, if the engine development contract was written after 1985, the production and development contractor are the same, and the warranty terms and conditions are the same or less stringent or than the specification in the development contract SOW, then the contractor's exposure to additional risk as a result of the warranty is considered to be low. Therefore, the expected cost of the warranty would be low as well. Low in this case is considered to be less than

or equal to two percent of the purchase price for each year the warranty is effective. Conversely, if the engine development contract was written prior to 1985, the production contractor is not the developer, and the production contract warranty contains terms and conditions that are new or more stringent than those used in the development contract SOW specification, then the contractor's exposure to additional risk as a result of the warranty is considered to be high. The expected cost of a warranty under these conditions will range from high to very high or greater than six percent of the purchase price per year.

As seen in the preceding chapter, the majority of engine systems procured in the years that followed the enactment of the law had development contracts that were signed prior the adoption of Section 2403 requirements. Because the new warranty requirements increased the contractor's exposure to risk for these systems, the true contractor's warranty cost would be expected to be moderate. This would result in an additional cost to cover the warranty of approximately four percent of the purchase price per year at best even if the terms of the warranty were consistent with those established in the development contract SOW and the weapon system producer was the developer as well. If the conditions were different then the true contractor's warranty cost would be even higher still.

The importance of understanding the risk implications

surrounding an engine's historical development and procurement when establishing the terms and conditions of the warranty is cannot be understated. Table I can be used by engine program managers early in the weapon system acquisition cycle to subjectively estimate what the true contractor's warranty costs should be based on several factors taken from the engine's development and procurement history.

2. Technological Advancements

The history of technological advancements and the level of technological advancement required to attain the lofty design goals established in a typical aircraft engine development contract need to be considered in as important aspects in the development of an effective warranty program. In the history of modern engine development, the application of advanced technologies have been continuously focused on the ever elusive goal of attaining more operating life out of an engine's hot section. If a dramatic shifts in the level of technological sophistication is required to attain these specifications the potential for uncertainty increases significantly. Historically, one can track the increase in operating life specification goals, the application of advanced technology, and the corresponding efforts of the contractors to protect themselves from increased exposure to risk right up to the Navy's latest engine development effort, the F414.

The current design specification for the F414's hot section operating life is 2000 hours. The cold section operating life specification is 4,000 hours. Using the average engine utilization rate of 30 hours per month, these specifications represent engine operating periods of approximately five and ten years, respectively, without scheduled removal. F414 program management representatives from both the Navy and GE are surprisingly optimistic that the newly adopted damage-tolerant design criteria discussed in the preceding chapter will assure the success of attaining these goals. These operating life figures represent a quantum leap from the currently achieved Fleet averages. In fact, the Navy has been hard pressed to achieve a 1000-hour hot section operating life promised in the newer tactical aircraft engines during their development. Thus, it is imperative that the PM consider the historical rate of technological advancement and the level required to attain the engine's design specification from a historical perspective when considering the appropriate warranty approach for a new program.

3. Contractor Performance and Reputation

The last historical consideration discussed in this section is the contractor's past performance and its reputation. It is important for the engine PM to accurately assess the contractor's past performance and consider its reputation from previous warranty negotiations, compliance and

overall corporate warranty philosophy as an integral part of the warranty development. It was evident in the vast majority of conversations between the researcher and both Navy and contractor representatives that the past performance and reputation of a company, with regards to honoring warranty claims and cooperating in a collaborative effort to resolve problems as they surface, is well known. As such, it should be considered a critical element in determining the potential for the success of a particular warranty approach.

This can be illustrated by the obvious differences in corporate philosophy found in the limitation of liability clauses written in the General Electric and Rolls-Royce engine contract warranties reviewed in the preceding chapter. The GE warranty philosophy establishes absolute limits of liability for the future performance of its engines. In contrast, it is evident from the wording found in the Rolls-Royce liability limitations that the corporation is willing to take a shared responsibility for the ultimate performance of its engine products.

Many of the Navy personnel interviewed as a part of this study attested to the craftiness and precision with which GE approaches warranty negotiations and its reluctance to "bite the bullet" over warranty issues. In several interviews between the researcher and now retired Navy Admiral Don Eaton, he spoke of the "arrogance" of General Electric and its gaming practices he observed as both the Commanding Officer of NAVPRO

Lynn Massachusetts and AIR-04. (Eaton, 1994)

In contrast, it is interesting to note that the General Electric's internal perspective of its corporation's sincerity in accepting responsibility for its engine's performance is quite the opposite. In a phone conversation between the researcher and Mr. Karl Matson, General Electric's F110 Program Manager, he made a point of elaborating on the company's willingness to work with the government on warranty issues. He went on to explain how GE had spent between three to four times the amount of money internally allocated within GE from the purchase price of the engine for the resolution of warranty issues with the F110. When asked to compare the Navy with the Air Force with regards to warranty issues, he did elaborate, however, on the extensive policy debates that had occurred between the Navy and GE as part of discussions on the topic and contract warranty negotiations and its differences in treating warranty costs. Despite the many disputes over the operating life reductions and various other performance problems associated with the F404 program, Mr. Matson's perspective was shared with the GE representatives from that program as well.

What you see and what you get is not necessarily the same. So it is very important for the PM and the Contracting Officer to consider the contractor's past performance and reputation in determining the appropriate warranty approach.

As stated earlier, there are many aspects that can be

significant to the development of the right warranty approach. This section elaborated on only a few that can affect the integration of the aircraft engine warranty into an acquisition strategy.

D. STATISTICAL SIGNIFICANCE OF ENGINE PERFORMANCE DATA

The data collected during the engine's Developmental Operational Test and Evaluation (DOT&E) Phase must be accurately analyzed and its relative statistical significance assessed properly when establishing warranty performance specifications. This is true for both operational characteristics (OCs) and reliability, maintainability, and availability characteristics (RMACs) specifications. It is the use of sound statistical analysis methodology when developing the control limits for operating life EPRs specifications, as described in the life management approach, that can significantly reduce the degree of uncertainty .

Several other methods have been used in warranty development and negotiation in the past to deal with the high degree of uncertainty and the costs associated with operating life EPRs. Included for the PM's consideration, they are:

1. Do not include operating life EPRs in the warranty.
2. Negotiate financial limitations or caps on the amount the contractor is liable to pay.
3. Use restrictive contractual language to limit the scope of remedies available to the government.

4. Reduce the operating life specification based on the results of the statistical analysis performed on the engine operating life data collected during DOT&E.

All of these have methods been successful in reducing the uncertainty and the contractor's liability to meet the operating life requirements established as EPRs. The early F404 contracts employed method 1. and had no explicit operating life EPR warranties. Although this goes against the current Navy approach, it is possibly the most effective economically. The problems with methods 2. and 3. is that they are inefficient and the government representatives feel "cheated" when the operational life specifications that were established in the development specification are not met.

As a classic case in point, in a recent presentation he gave at the Naval Postgraduate School Captain Don Berkebile, USN, the Comptroller from COMNAVAIRPAC, told the "horror story" of the F404 and its impact on the Fleet Flying-hour Program (FFP). The FFP is responsible for funding both fuel and repair parts for aircraft operations. According to Captain Berkebile, the reductions made to the operating life or "life limits" of various components within the F404 before they are scheduled or "forced" to be removed for maintenance are being blamed for a budget variance due to un-programmed maintenance costs of over $58 million in FY94. The F404 life limit reductions, the Captain was referring to, were issued by NAVAIR in response to analyses conducted on engine failures

experienced in the Fleet. The result was a significant increase in the engine's depot level maintenance requirements and costs. The Captain's anger and frustration over the situation was obvious. He stated emphatically that "we should take GE to court for breach of contract and force them to give us the engine contracted for."

After comparing the life limit figures used in his presentation with the specifications found in the production contract warranties, the researcher determined that these reductions had resulted in operating life limits that were very close to the warranted operating life that was set at 75% of design. When the Weibull distribution functions are applied and the restricted remedies available to the government are considered, it becomes evident that the Navy does not have much of case and less to gain by taking GE to court.

The redesign remedies in the Lot XI contract are limited to engineering and hardware support only. Parts and labor are included only if the actual performance drops below half the warranted life. Effectively, this makes the redesign threshold for operating life at 37.5% of design. Additionally, a financial limit of $8.5 million for all operating life remedies is included.

That GE is concerned about the potential liability of meeting operating life specifications established in the warranty is evidenced by the fact that there are no engineering redesign provisions in the Lot XII contract

warranty at all. In fact, the warranty for Lot XII specifically requires that any design and development work necessary for qualification of a modification to eliminate the cause shall be funded or conducted by the Government. The point is that the government can not afford to pay the requisite insurance premium necessary to fully cover the contractor's risk of meeting highly uncertain specifications like operating life. Accordingly, GE and the Navy employed methods 2. and 3. listed above to limit the contractor's risk and liability to within the program's cost constraints.

The last method, number 4 cited as above, refers to the life management approach introduced and discussed in earlier chapters. This approach is being planned for inclusion in the warranty plan for the F414. In discussions with Mr. Patrick McLaughlin, a NAVAIR Contracting Officer formerly assigned to the F414 program, this approach appears to solve the majority of the uncertainty problems associated with the establishing realistic operational life specifications for use in the warranty contracts early in the production phase. The problem with this approach is that it does not offer the logisticians a firm target for planning the requisite logistic support. The life management approach is seen by many as an evolutionary step in weapon system program management and a key to the successful integration of engine warranty development with an acquisition strategy. The real costs and benefits are yet to be determined.

E. UNCERTAINTY, RISK AND EPR SELECTION

According to the ASG, the integration of warranty development into the acquisition strategy is an aspect of cost and risk sharing (Nelson 1984). The uncertainty, risk, cost and effectiveness of an aircraft engine warranty can vary dramatically depending on what specifications are chosen to include and how the warranty is worded. This is particularly true with regards to the EPRs.

On the one extreme, the Navy's "no-cost" warranty policy may, in fact, be applicable if the proper EPRs are selected and matched with the terms and conditions of the warranty and the history of the engine development and procurement is appropriate. On the other hand, for a warranty which uses technically advanced EPRs and includes terms and conditions having a high degree of uncertainty which could expose the contractor to an inequitable share of risk, the cost could reasonably run as high as 10 percent of total hardware cost for each year the warranty is effective. The use of advanced technology in engine system development programs like the F414 "implies the presence of large amounts of uncertainty and information asymmetry" (Kuenne, 1987).

It must be understood that "there is no free lunch". If a engine system contractor is asked to assume a greater portion of the risk, or sign up to an EPR or warranty clause that contains a high degree of uncertainty, they will respond with a higher warranty price, contract cost or seek specific

financial limits of liability to protect the interest of the company.

In order for a contractor to price a warranty, they must assess the level of uncertainty and risk of the specific terms and conditions in the contract. The contractor's estimate of cost is undoubtedly the best way to determine the level of uncertainty and risk associated with any particular EPR. The fact that the Navy does not separately negotiate its warranties often makes determining their cost particularly difficult. Given the lack of information, the next best way to determine the expected cost is from observing and analyzing the limits of liabilities established to protect the contractor from level of risk and uncertainty.

Risks can be calculated mathematically based on the probability distributions that are derived from historical data and can be insured against and often result in a specified dollar limit of liability. Uncertainty, on the other hand, can only be subjectively estimated. Depending on the contractor's sense of the degree of control in attaining certain performance criteria, the contractor will seek to limit liability of uncertainty through the imposition of technical limitations and restrictive contractual language.

It appears as if there is a high degree of correlation between risk and Operational Characteristics (OCs) as well as uncertainty and Reliability, Maintainability, Availability Characteristics (RMACs). This was evidenced in the way the

engine contractors negotiated financial limitations, if any, on warranties covering OCs, like specific fuel consumption or thrust deterioration. Conversely, RMACs like operating life found in the F404 and F110 warranties that included redesign as a remedy have resulted in the contractor's negotiation of a warranty having a complex technical determination of warranty breach and limits to responsibility for aspects of the redesign via restrictive contractual language, as well as specific financial limitations. So, in the absence of separately negotiated contractor warranty cost, NAVAIR engine Program Managers can use the contractor's desire to negotiate limits of liability as an indicator of the level uncertainty and risk associated with those selected EPRs and seek to avoid entering into any warranty that attempts to perform insurance functions.

The impact of a warranty's effectiveness and true cost on the total life cycle cost of a complex dynamic weapon system like an aircraft engine is substantial. Understanding the uncertainty and risk is associated with each warranty clause is extremely important when determining warranty cost-effectiveness.

F. AIRCRAFT ENGINE WARRANTY COST ANALYSIS

According to recent discussions with engine Program Managers and Contracting Officers it has become common practice not to perform engine system warranty cost analysis.

This has been attributed to the Navy "no-cost" warranty policy and the inability of the current models used by AIR-524 to account for the complexities of the warranties used. As a result, the cost-effectiveness analysis of engine warranties is often foregone (McLaughlin, 1994). Following the guidelines below might prove to be a more effective way to approach this situation.

NAVAIR engine Program Managers should continue to conduct an analysis with the best information available. While it is understood that the assumption of a free warranty precludes the performance of an intelligent warranty cost-benefit analysis, this does not mean that an analysis to determine the warranties effectiveness cannot or should not be conducted.

1. Look at the Big Picture

A common sense review of the program's history and future acquisition plan can be an effective means of precluding costly and inefficient warranty approaches and clauses. For example, if the program is still in development, like the F414, consideration of the Life Management approach will greatly reduce the level of uncertainty associated with operational life EPRs. In contrast, with the a very limited purchase, like the F402-RR-408, requesting coverage of operating life EPRs well beyond the period of production adds considerable additional cost to the warranty. This will require Rolls-Royce to keep accountants and administrators to

manage the business aspects of the warranty on the payroll and might require retaining engineers and artisans in case any warranty work is required as well.

2. Keep It Simple

Pursue the use of the simplest life cycle cost analysis model available. Adapting the AIR-524 WARPC model to the basic warranty provisions in the new generic aircraft engine warranty and ensuring an estimate or the actual total contractor's warranty cost is used should provide more than adequate results. Although the current models available in AIR-524 cannot account for all the complexities included in the aircraft engine warranties used today, the manhours and cost involved in developing such a model and performing that sort of detailed analysis is prohibitive (AIR-524, 1988). AIR-524 is aware that the engine Program Managers would like to have engine warranty life cycle cost analysis models developed that include separate operating life specifications for hot and cold section components. Unfortunately, developing one that will do that is not a high priority in (Hu, 1994).

The key to a better life cycle cost analysis is not in the details, it is in the assumptions. Assumptions like the Navy's "no-cost" warranty need to be replaced with estimates or the contractor's actual total warranty cost. Likewise, the use of deterministic estimates of outcomes for potential benefits should be replaced with probabilistic ones wherever possible.

Remember, the more technical and difficult the analysis the more it costs. Keeping it simple keeps it cheap.

3. Discontinue NAVAIR Warranty Cost Practice

Using the contractor's warranty administration cost as an estimate for the contractor's total warranty cost in the models is grossly misleading and should not be continued. While it is understood that this is done because of the current "no-cost" warranty policy and the fact that the administrative cost is available because it is submitted as a separate line item for contract negotiations, this is by no means reflective of the total cost or liability associated with the comprehensive aircraft engine warranties being negotiated.

4. Get the Best Cost Data Available

Require the contractor to provide estimated warranty cost figures as part of the development contract, issue the production Request For Proposal (RFP) with a warranty option or use "should-cost" estimates. Should cost estimates can be derived based on the complexity and risk associated with the warranty approach and the unit cost of the engine.

5. Include Warranty Life Cycle Cost Analysis Costs

Remember that performing a life cycle cost analysis cost money. Accordingly, be sure to consider the performance of warranty cost-analysis as another administrative cost element of the Navy's warranty program when assessing the

warranty's costs and benefits. This will incentivize the use of simpler, less time consuming analysis techniques.

6. Do Not Buy Insurance

Consider the economic inefficiency aspects of the government buying insurance from a contractor, especially when the contractor has little or no control over the system achieving the required level of performance for the period of the warranty. Avoid the use of any warranty clause that attempts to insure the government against uncertainty as it is not cost effective.

G. CONCLUSION

Developing an effective efficient engine warranty is a real art. How well the Program Manager and Contracting Officer execute this responsibility depends on their understanding of the importance of integrating the use of warranties as a control tool throughout the engine system life cycle. They must be aware of the many historical factors to consider and employ sound statistical analysis practices, particularly in establishing operating life performance specifications based on data collected during the engine test and evaluation phase. Finally, and probably most importantly, they must be aware of the inefficiencies associated with the government insuring itself against uncertainties and risks, and importance of establishing essential performance requirements which support the operational requirements of the engine and the mission

needs of the aircraft it is intended to power.

The bottom line is, the more successful the Program Management Team is at integrating warranties that motivate the contractor to design, build and deliver an engine that performs as expected and, perhaps, enhance the quality of the engine produced in all measurable parameters, the more effective the engine acquisition strategy will be.

VII. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The primary objective of this thesis was to determine if there was a better way to develop aircraft engine warranties that would meet the federally mandated weapon system warranty requirements. The focus of the analysis was to look at the potential advantages of integrating the development of the production contract warranty into an aircraft engine acquisition strategy. The goal was to develop a common sense approach that would maximize the effectiveness of the warranty and minimize engine life cycle costs within the constraints of the current political environment, warranty policy guidance and program management requirements.

A. SUMMARY

Chapter II presented a chronological review of the issues and events that have shaped the use of warranties in DoD weapon system procurement. The discussion covered the politics and congressional action surrounding all DoD weapon system warranties in general, as well as the pertinent policy guidance and program management requirements affecting the development of Navy aircraft engine warranties in particular. The chapter also introduced the role of warranties in an acquisition strategy and program management and concluded with a review of the Navy's aircraft engine program management.

Chapter III reviewed the economic principles of warranties and warranty costs. The concept of the "no-cost" warranty was introduced and the chapter closed with a discussion of the impact of warranties on life cycle costs and the Component Improvement Program (CIP). Chapter IV was the first of three chapters dedicated to the analysis of weapon system warranties. It presented the results of an economic analysis of mandated warranty requirements found in Section 2403, the FAR and DFARS, and an analysis of the current warranty policy guidance as well. The chapter finished with an assessment of the warranty program management at all levels within the DoD and highlighted particular strengths and weaknesses.

Chapter V reported the findings of the individual analyses conducted on the warranties for several major engine programs. It tied the theory and economic principles of warranties discussed in the Chapter III to the wording used in the actual warranties. Each individual analysis looked at the compatibility of the warranty with the engine acquisition strategy, and in some cases, the aircraft acquisition strategy as well. Chapter VI provided a set of guidelines that were developed by the researcher to assist aircraft engine Program Managers in the future development and integration of effective efficient warranties into an engine acquisition strategy.

B. CONCLUSIONS

The conclusions derived as a result of the research and analysis are grouped into a similar order as the material was presented in the thesis. This section also includes a review of conclusions drawn from answering the primary and subsidiary research questions asked at the beginning of the research effort.

1. Economic Realities of Weapon System Warranties

Despite the belief of some, warranties of any nature have a cost associated with them. This may be either explicitly or implicitly expressed in the contract, but indeed "there is no free lunch!" furthermore, the price paid for weapon system warranty may be to high from a life cycle cost perspective. Warranties can dramatically affect the life cycle cost of a weapon system. To be able analyze the life cycle cost impact of a warranty it is necessary to price and negotiate the cost of the production contract warranty separately.

The economic efficiency of a weapon system warranty depends not only on the cost but on the nature or type of the warranty, the limitations of contractor liability, and the nature of the remedies as well. The nature of the warranty depends on the degree of uncertainty associated with the specification, the level of contractor control, and the duration of contractor's exposure to risk. The limitations of

contractor liability can be imposed by qualifying the terms of the breach or in actual financial limits set on any clause. The nature of the remedies available affects efficiency of the warranty as well. This was made apparent in the examples given on redesign remedies and financial reimbursement as well given in Chapter V.

The DoD's desire to execute warranties on specifications having a high degree of uncertainty and to extend the duration of weapon system warranties significantly into the post-acceptance period causes the warranty to take on insurance functions. The practice of the DoD purchasing "insurance" in the form of a warranty from the weapon system producer has been shown in studies like the IDA paper to be inefficient because of the contractor's aversion to risk.

2. Congress and Politics

As the proportion of federal funds available for allocation through discretionary spending programs continues to shrink, Congress' desire to control this spending will only serve to intensify the level of Congressional oversight and involvement in DoD procurement. The OSD's continuing efforts aimed at reducing the level of Congressional involvement have wrongly focused its energies and strengths with regard to weapon system warranties.

3. The Law and Regulations

Nothing present in either the Law (10 U.S.C. 2403) or the current FAR and DFARS warranty regulations would preclude the development, negotiation or administration of an efficient effective weapon system warranty. However, the latitude and flexibility given to the Program Manager and particularly the Contracting Officer does not prevent them from developing or negotiating an ineffective and/or inefficient warranty.

4. DoD Warranty Policy Guidance

The lack of warranty policy guidance from OSD is the result of the Department's political focus. This lack of guidance has significantly hindered the Program Managers potential to develop and administer effective efficient weapon system warranties throughout the DoD. Additionally, the lack of guidance makes the training of DoD acquisition professionals in warranties as an integral part of the weapon system's acquisition strategy less significant and more difficult.

On the Navy side of the house, the ambiguity in the ASN's warranty policy guidance has resulted in a misinterpretation of its intent by the Naval Air Systems Command as evidenced in NAVAIR INSTRUCTION 13070.7. The poor direction and guidance can attributed to a number of problems experienced by the Program Managers throughout the Navy. NAVAIR's interpretation of ASN's warranty policy has resulted

in a NAVAIR warranty policy that makes it virtually impossible for Program Managers and Contracting Officers to perform a reasonable financial analysis of the weapon system warranties being developed or used.

5. Warranty Program Management

A weapon system warranty program does not exist at the OSD level. The responsibility for managing warranties was delegated to the service secretaries. The OSD's lack of interest in the subject, short of avoiding any further Congressional direction or political embarrassment, is evident in the fact that warranties are not included in the DoD Acquisition Directive and are not included as a required element under the DAB review process.

Within the DoN, ASN (RD&A) does not manage a weapon system warranty program per se either. In essence, they have tasked the CNO with managing the program and, in effect, do nothing in the day-to-day management of warranties.

The CNO N4 and N8 Staffs have been actively involved in the management of the weapon system warranty program and has included a warranty review as part of the LRG audit for major programs. The effectiveness of their role will diminish significantly if the responsibility for conducting the LRG audit is delegated completely to the Systems Commands.

The NAVAIR Warranty Program lacks direction. AIR-516 has been vocal about its inability to exert control over the

factions within NAVAIR that are actively involved in warranty development, negotiation and administration. Their discomfort in the role of Warranty Program Manager is certainly understandable. To quote one Navy officer involved in the program, "Managing a program like warranties out of AIR-516 is like trying to herd cats".

The warranty cost analyses that are being conducted are ineffective and misleading due to the practice of using the contractor's warranty administration cost in the models as the real costs of the warranties.

Finally, the shifting of the AIR-04 point of contact for warranty management to NAMO at this time significantly weakens the program.

6. Aircraft Engine Warranties

The NAVAIR Propulsion and Power Division (AIR-536) continues to be on the cutting edge of weapon system warranty development and has gained tremendous insights as a result of efforts to date and the difficulties encountered.

There continues to be a misconception that operating life warranties which can be categorized as insurance warranties are effective. Fortunately, AIR-536's plan to incorporate the life management approach into the warranty plan for the F414 will reduce the insurance characteristics of the operating life EPRs. Depending on the final wording of the warranty clauses themselves, the life management approach

should significantly reduce the uncertainty and risk typically associated with the early establishment of operating life limits for dynamic engine components and will improve the overall effectiveness of the warranty. The effectiveness of this initiative is certainly limited by not having established warranty specifications prior to entering DEMVAL. With the F414 representing the lead program employing this approach, its true effectiveness is yet to be determined.

7. General Conclusions

Although a detailed quantitative review using the most current warranty cost-benefit analysis models employed by the Navy and other services was not possible, the research and analysis were enlightening. There is definite potential to improve "The System" at both the OSD and ASN level and stay within the Congressionally mandated requirements. However, the bipolar attitude of personnel within the DoD towards the federally mandated weapon system warranties inhibits the effective use of warranties as a risk management tool to aid in producing higher quality systems at minimal life cycle cost.

8. Primary Research Question

Several of the conclusions presented thus far were realized as a result of attempting to answer the primary research question which was:

- **How can the Navy integrate the required warranty clauses,**

including essential performance requirements (EPRs) into the aircraft engine acquisition strategy to maximize effectiveness and reduce life cycle cost?

To summarize then in answer to this question, the engine Program Manager must fully understand and start the warranty development process early in the engine system life cycle and take into consideration the economic efficiencies of the different warranty types as they relate to the EPRs chosen and the limitations imposed on them by the political and military environment. Despite the environment and the Navy's unique accounting of warranty costs, a substantial amount of effort has gone into improving warranty development, and there are alternative means available to evaluate the warranty and ensure aircraft engine warranties are as effective and cost efficient as possible. The main goal of this thesis was to develop a guide to assist Program Managers in assessing the strengths and weaknesses of their integration of warranties in the acquisition strategy. That goal was achieved. The guide is presented in Chapter VI.

9. Subsidiary Research Questions

- **How does the Navy estimate warranty costs and benefits?**

With regard to costs, the Navy uses the cost of warranty administration as an estimate of the contractor's warranty cost. This practice is terribly misleading and should be discontinued. The use of "should-cost" estimates for use in

evaluating warranties when a specific procurement costs are unknown might be useful.

- **Are weapon system warranties cost-effective?**

It depends on how much the Government pays, what the true benefits received from the warranty are, and the nature or function of the warranty written. Economic theory supports the notion that it is more efficient for the government to be a self insurer. Therefore, buying a weapon system warranty which is written in such a way that it perform an insurance function is not cost-effective. According to economic theory, however, assurance and incentive warranties can be constructed for weapon systems in such a way as to be cost-effective.

- **What are the logistic and life cycle cost impacts associated with the different warranty types?**

As mentioned above, the insurance warranties are the only type which are known not to be cost-effective for the DoD. However, each individual warranty must be evaluated on its own merit. An unfortunate consequence of the problems associated with the warranty cost analysis assumptions is that many of the NAVAIR programs do not actually perform the required cost-benefit analysis of their warranties.

In general, the expected reduction in life cycle cost from a corresponding reduction in the requirement for efforts like CIP has not materialized from the use of weapon system

warranties. Warranties have been ineffective in reducing the impact associated with the reduction of the F404 life limits as well. As such, they generally represent an additive cost to the program and do not reduce the life cycle cost. The researcher was unable to determine if there was any true reduction in the life cycle cost of any engine program that resulted from the employment of any specific warranty type.

- **What is the impact of the current political initiatives on warranty policy and program management?**

The current political initiatives have done little to influence the DoD warranty policy and program management. The vast majority of senior DoD acquisition professionals interviewed as part of this study are still opposed to the federally mandated weapon system warranties. At the OSD/ASN level, it is primarily because they resent being told by Congress how to do business.

The only reason many Program Managers include warranties in their programs is because they are required to do so by law. They concede that if the warranty is found to be ineffective or too expensive then it is more justification to do away with them.

The Navy's adoption of the "no-cost" warranty policy was an attempt to reduce the impact of the mandated requirements and has resulted in precluding the performance of any realistic life cycle cost analysis.

C. RECOMMENDATIONS

1. Secretary of Defense

The Office of the Secretary of Defense should take an active role in determining the best means for developing, negotiating and administering weapon system warranties.

The OSD should sponsor the development of a standardized set of guidelines for all services similar to those recommended by the Glenn Bill that includes guidelines for warranty development.

A review of the weapon system warranty plan should be included as a required element of the DAB review process and be conducted concurrent with the TEMP review for Milestones I and II.

The DoD 5000 series instructions should be updated to reflect the mandatory use of weapon system warranties.

2. Secretary of the Navy

The Office of Secretary of Navy should encourage the OSD to establish a standardized set of guidelines for developing, negotiating and administering weapon system warranties as well as determining if pursuing a waiver is appropriate.

The current SECNAV "no-cost" warranty policy should be changed to reflect the need for the separate pricing and negotiation of warranties in weapon system contracts.

SECNAV INSTRUCTION 4330.17 should be changed to

reflect the change in warranty pricing policy.

SECNAV should require OPNAV N4 to remain as the convening authority for the LRG audit and the review of warranties as part of that process.

3. Chief of Naval Operations

The Chief of Naval Operations should overturn the current recommendation under review to delegate the responsibility of convening the LRG audit to the Systems Commands and retain N4 as the convening authority for the LRG audit and continue review of warranty plan as part of the audit process.

N4 should oppose the use insurance warranties in weapon systems production contracts because of their known economic inefficiencies.

N8 should support the use of the life management program approach for improvements for all weapon systems including aircraft engines.

N8 should determine the appropriate funding source for life management improvements (APN or RDT&E).

4. Commander, Naval Air Systems Command

The Commander, Naval Air Systems Command should support the retention of N4 as the convening authority for the LRG audit and continue to review the weapon system warranty plan as part of the audit process.

The life management program approach should be

supported for all weapon systems including aircraft engines.

The NAVAIR warranty program manager should be within AIR-04. As the Assistant Commander for Logistics and Fleet Support and the leading NAVAIR member on the LRG audit, AIR-04 has the positional authority and program management responsibility to effectively manage the warranty program.

The current warranty life cycle cost analysis models and assumptions used in the analysis procedures should be reviewed to determine the most effective means of analysis.

The use of insurance warranties in system production contracts should be discontinued because of their known inefficiencies.

D. THESIS STUDY RECOMMENDATIONS

The researcher recommends that the following specific areas for further research be conducted by students at the Naval Postgraduate School.

- Determine the most effective way to develop, negotiate, and administer weapon system warranties that enhance quality and reduce system life cycle costs in an effort to assist OSD in the development of standardized guidelines for all services.
- Perform an analysis on the various warranty life cycle cost models and techniques used throughout the DoD to determine the most effective and efficient means of performing such analyses.
- Perform an analysis on the life management approach and compare with Reliability Centered Maintenance (RCM) for similarity and compatibility.

APPENDIX A SECTION 794

DEPARTMENT OF DEFENSE APPROPRIATIONS ACT OF 1984

SECTION 794

SEC. 794. 1. Except as otherwise provided in this section, none of the funds appropriated by this or any other Act may be obligated or expended for the procurement of a weapon system unless the prime contractor or other contractors for such system provides the United States with written guarantees:

a. that the system and each component thereof were designed and manufactured so as to conform to the Government's performance requirements as specifically delineated

   - in the production contract, or

   - in any other agreement relating to the production of such system entered into by the United States and *the contractor*;

b. that the system and each component thereof, at the time they are provided to the United States, are free from all defects (in materials and workmanship) which would cause the system to fail to conform to the Government's performance requirements as specifically delineated

   - in the production contract, or

   - in any other agreement relating to the production of such system entered into by the United States and *the contractor*; and

c. That, in the event of a failure of the weapon ystem or a component to meet the conditions specified in clauses a and b.:

- the contractor will bear the cost of all work promptly to repair or replace such parts as are necessary to achieve the required performance; or

- if *the contractor* fails to repair or replace such parts promptly, as determined by the Secretary of Defense, the contractor will pay the costs incurred by the United States in procuring such parts from another source.

2. A written guarantee provided pursuant to subsection 1. shall not apply in the case of any weapon system or component thereof which has been furnished by the Government to a *contractor*.

3. The Secretary of Defense may waive the requirements of subsection 1. in the case of a weapon system if the Secretary:

a determines that the waiver is necessary in the interest of the national defense or would not be cost-effective; and

b. notifies the Committees on Armed Services and Appropriations of the Senate and the House of Representatives in writing of his intention to waive such requirements with respect to such weapon system and includes in the notice an explanation of the reasons for the waiver.

4. The requirements for written guarantees provided in subsection 1. hereof shall apply only to contracts which are awarded after the date of enactment of this Act and shall not cover combat damage.

APPENDIX B SECTION 2403

TITLE 10 United States CODE

Section 2403

2403. Major weapon systems contractor guarantees

(a) In this section

(1) "Weapon System" means items that can be used directly by the armed forces to carry out combat missions and that cost more than $100,000 or for which the eventual total procurement cost is more than $10,000,000. Such term does not include commercial items sold in substantial quantities to the general public.

(2) "Prime contractor" means a party that enters into an agreement directly with the United States to furnish part or all of a weapon system.

(3) "Design and manufacturing requirements" means structural and engineering plans and manufacturing particulars, including precise measurements, tolerances, materials, and finished product tests for the weapon system being produced.

(4) "Essential performance requirements", with respect to a weapon system, means the operating capabilities or maintenance and reliability characteristics of the system that are determined by the Secretary of Defense to be necessary for the system to fulfill the military requirements for which the system is designed.

(5) "Component" means any constituent element of a weapon system.

(6) "Mature full-scale production" means the manufacture of all units of a weapon system after the manufacture of the first one-tenth of the eventual total production or the

initial production quantity of such system, whichever is less.

(7) "Initial production quantity" means the number of units of a weapon system contracted for in the first year of full-scale production.

(8) "Head of an agency" has the meaning given that term in section 2302 of this title.

(b) Except as otherwise provided in this section, the head of an agency may not after 1 January 1985, enter into a contract for the production of a weapon system unless each prime contractor for the system provided the United States with written guarantees that--

(1) the item provided under the contract will conform to the design and manufacturing requirements specifically delineated in the production contract (or in any amendment to that contract);

(2) the item provided under the contract, at the time it is delivered to the United States, will be free from all defects in materials and workmanship;

(3) the item provided under the contract will conform to the essential performance requirements of the item as specifically delineated in the production contract (or in any amendment to that contract); and

(4) if the item provided under the contract fails to meet the guarantee specified in clause (1), (2), or (3), the contractor will at the election of the Secretary of Defense or as otherwise provided in the contract--

(A) promptly take such corrective action as may be necessary to correct the failure at no additional cost to the United States; or

(B) pay costs reasonably incurred by the United States in taking such corrective action.

(c) The head of the agency concerned may not require

guarantees under subsection (b) from a prime contractor for a weapon system, or for a component of a weapon system, that is furnished by the United States to the contractor.

(d) Subject to subsection (e)(1), the Secretary of Defense may waive part or all of subsection (b) in the case of a weapon system, or component of a weapon system, if the Secretary determines---

(1) that the waiver is necessary in the interest of national defense; or

(2) that a guarantee under that subsection would not be cost-effective.

The Secretary may not delegate authority under this subsection to any person who holds a position below the level of Assistant Secretary of Defense or Assistant Secretary of a military department.

(e) (1) Before making a waiver under subsection (d) with respect to a weapon system that is a major defense acquisition program for the purpose of section 139a of this title, the Secretary of Defense shall notify the committees on Armed Services and on Appropriations of the Senate and House of Representatives in writing of his intention to waive any or all of the requirements of subsection (b)with respect to that system and shall include in the notice an explanation of the reasons for the waiver.

(2) Not later than February 1 of each year, the Secretary of Defense shall submit to the committees specified in paragraph (1) a report identifying each wavier made under subsection (d) during the preceding calendar year for a weapon system that is not a major defense acquisition program for the purpose of section 139a of this title and shall include in the report an explanation of the reasons for the waivers.

(f) The requirement for a guarantee under subsection (b)(3) applies only in the case of a contract for a weapon system that is in mature full-scale production. However, nothing in this section prohibits the head of the agency concerned from

negotiating a guarantee described in subsection (b)(3), the Secretary shall comply with the notice requirements of subsection (e).

(g) Nothing in this section prohibits the head of the agency concerned from---

(1) negotiating the specific details of a guarantee, including reasonable exclusions, limitations and time duration, so long as then negotiated guarantee is consistent with the general requirements of this section;

(2) requiring that components of a weapon system furnished by the United States to a contractor be properly installed so as not to invalidate any warranty or guarantee provided by the manufacturer of such component to the United States;

(3) reducing the price of any contract for a weapon system or other defense equipment to take account of any payment due from a contractor pursuant to subclause (B) of subsection (b)(4);

(4) in the case of a dual source procurement, exempting from the requirements of subsection (b)(3) an amount of production by the second source contractor equivalent to the first one-tenth of the eventual total production by the second source contractor; and

(5) using written guarantees to a greater extent than required by this section including guarantees that exceed those in clauses (1), (2), and (3) of subsection (b)and guarantees that provide more comprehensive remedies than the remedies specified under clause (4) of that subsection.

(h) (1) The Secretary of Defense shall prescribe such regulations as may be necessary to carry out this section.

(2) This section does not apply to the Coast Guard or to the National Aeronautics and Space Administration.

(Added Publ. L 98-525, Title XII. 123-4(a), Oct. 19,1984,98 Stat. 2601)

APPENDIX C COMMON AIRCRAFT ENGINE WARRANTY

DRAFT COPY

22 March 1994

H- ENGINE WARRANTY

(a) DEFINITIONS:

(1) ACCEPTANCE - The act by which the Government assumes for itself, or as an agent for another, ownership of the identified Supplies. Acceptance occurs, for example, upon execution by an authorized Government representative in the Acceptance Block of the DD Form 250.

(2) CONSUMABLE - A component that is replaced regardless of apparent condition during maintenance, inspection, or repair. Consumable materials shall include filters, preformed packings (0-rings), seals, gaskets and other engine items that are discarded regardless of apparent condition LAW the engine technical manuals. Consumable materials are identified by source, maintenance, and recoverability (SM&R) coding.

(3) DEFECT - As used herein means any condition or characteristic in any supplies furnished by the contractor under this contract that is not in compliance with the requirements of the contract.

(4) DESIGN AND MANUFACTURING REQUIREMENTS - Structural and engineering plans and manufacturing particulars, including precise measurements, tolerances, materials, and the finished product tests as required by this contract for the Warranted items being procured.

(5) ENGINE OPERATING HOURS - Total engine operating time as determined by the engine monitoring systems. In the event the engine monitoring system is inoperative, unavailable, or data is incomplete, such time shall be calculated in a manner such as per I fill in blank 1, or as reported by the flight crew and recorded in the engine log book.

(6) FAILURE - The breakage of a part, malfunction of a part or damage to a part which renders it unserviceable, or a condition which causes or would cause a warranted item to fail

to meet any characteristic required for operation. Although a failure may be an indication of a defect, a failure is not a defect by definition.

(7) FOREIGN OBJECT DAMAGE (FOD) - Damage to an engine resulting from ingestion of material not installed within the engine.

(8) REDESIGN - A change to design and manufacturing requirements. Redesign shall include any testing required to validate/qualify the proposed change as well any other effort normally associated with an Engineering Change Proposal (ECP).

(9) REPAIR - To restore an engine or component to serviceable condition.

(10) SERVICEABLE - Operational and acceptable for continued use under the criteria established by the applicable maintenance publications.

(11) SYSTEMIC FAILURE - A failure mode or characteristic that is identified as being common to warranted items delivered under contract. ***[Insert a method of determining systemic failure]***

(12) WARRANTED ITEM - Any engine and all original constituent components/modules/parts thereof delivered under this contract, excluding Government-Furnished Property (GFP). Warranted items also include all new Contractor-supplied or contract-overhauled replacement components/modules/items as may be installed on engines delivered under this contract to remedy a defect in an original component/module/item.

(13) WARRANTED RESULTANT DAMAGE - Damage suffered directly by or induced primarily in an engine item from a warranted defect in an item provided by the Contractor. The term excludes damage to other engines or any property external to the instant engine or any consequential damages.

(b) COVERAGE AND PERIOD: Notwithstanding inspection and acceptance by the Government of supplies furnished under this contract or any provision of this contract concerning the conclusiveness thereof, the Contractor warrants:

(1) That at time of delivery and for ***[specify period]*** any warranted item Originally delivered under this contract shall conform to the design and manufacturing requirements.

(2) That any warranted item Originally delivered under this contract shall be free from all defects in material and workmanship at the time of its delivery to the Government and

for ***[specify period]***.

(3) That any warranted item Originally delivered under this contract, shall meet the essential performance standards and requirements as specified below for ***[specify period]***.

(4) Any warranted items repaired/replaced pursuant to this warranty are subject to the provisions of this clause for the remaining period of the warranty on the warranted items originally delivered.

(c) NOTIFICATION

(1) The Contractor shall be notified in writing of any breach of the warranty set forth in "Coverage and Period" above including a description of the breach within ***[specify period]***, after discovery of the defect.

(2) Written notice may consist of any of the following: a letter from the Contracting Officer or his duly authorized representative, and/or ***[specify deficiency report document or maintenance document]***.

(3) Should the Contractor discover any breach of warranty prior to receipt of Government notification, the Contractor shall notify the Contracting Officer in writing within ***[specify period]***, after discovery of the defect.

(d) REMEDIES:

(1) GOVERNMENT ELECTION: In the event of a breach of warranty, the Government shall decide which of the following remedies shall be applied:

(i) CONTRACTOR REPAIR/REPLACEMENT: The Contractor shall, at its election, either repair or replace the warranted item. Items repaired or replaced under this warranty shall be Presented for Government inspection at a location agreeable to both parties.

a) The Government will deliver the warranted item to the Contractor within ***[fill in]*** days of discovery of a warranted defect. Warranted items will be shipped to the following contractor facilities:

[List Addresses]

b) The contractor shall repair/replace warranted items within ***[fill in]*** days from the date when both notification and the item are received.

c) The Contractor shall repair/replace all items

or components rendered unserviceable or destroyed in correcting the warranted defect.

d) Upon Government direction from Contracting Officer as authorized by FAR 51.101, the Contractor may utilize Government stocks to effect repair and, as mutually agreed, replace stocks used (with new, rebuilt, or serviceable items of like value) within normal production lead-time.

(ii) GOVERNMENT REPAIR: In the event that repair/replacement is undertaken by or through the Government, the Government may elect from the following:

a) The Contractor shall provide all serviceable components required to repair the warranted item in exchange for unserviceable components, returned to the contractor's designated facility.

b) Repair the warranted item using Government assets and not return the unserviceable components to the Contractor. In this event: ***[insert remedy]***

[FOR EXAMPLE:

1) Equitable consideration may be negotiated between parties, or

2) An equitable downward adjustment to the contract price shall be made of $_____ per unserviceable warranted item replaced or repaired, not to exceed $ _____ for a single event.]

(iii) SYSTEMIC FAILURE: In the event it is determined that a systemic failure exists and that failure was directly caused by a warranted defect, the Contractor shall provide:

a) All engineering, hardware, and testing necessary to complete a redesign as required to eliminate the cause of the breach.

b) All items necessary to incorporate the redesign in all engine and Components/items under warranty at the time of notification.

c) All technical data (whether new, revisions, or updating) occasioned by the redesign and retrofit.

(2) UNSERVICEABLE COMPONENT DISPOSITION: In lieu of return to the Contractor's repair facility, the Government may, with the Contractor's concurrence, scrap the unserviceable component.

(3) DISPUTES CLAUSE: Failure of the parties to agree concerning the application of these remedies shall be subject to FAR 52.233-1, "Disputes."

(4) PROCEDURES REGARDING NON-WARRANTED REPAIRS: If, upon Preliminary analysis of the component/part, the cause of failure is not within the Parameters of the warranty or if Non-warranted repairs must be performed in conjunction with those repairs inclusive of the warranty, Contractor shall stop all Non-warranted work and contact the Contracting Officer for further direction.

(e) VERIFICATION/VALIDATION: Contractor shall have access to data and defective hardware as reasonably necessary to perform warranty breach validation/verification.

(f) TRANSPORTATION AND RISK OF LOSS: Transportation of defective supplies to the Contractor's designated repair facility and back shall be via Government Bill of Lading with the Government assuming risk of loss to the supplies in transit. The risk of loss of any such item while in the Possession of the Contractor shall be Governed by the "Government Property" clause.

(g) MARKING:

(1) For each aircraft, missile, or engine delivered, the Contractor shall Provide complete, accurate, and legible warranty information in the Miscellaneous History Section of the Aircraft/Aeronautical Equipment Service Record as part of the acceptance of each aircraft, missile, or engine. The warranty page(s) shall be marked as "PERMANENT RECORD" and include, as a minimum, the following:

(i) "WARRANTED ITEM"

(ii) Manufacturer or entity providing the warranty

(iii) Contract number

(iv) Expiration of the warranty. (NOTE: If expiration is for a calendar Period of time and/or hours/cycles of usage, the marking must Provide a firm expiration. Stating that warranty will expire "x" months from acceptance does not, in itself, Provide clear guidance to equipment user).

(v) National Stock Number, Part Number and Serial Number.

(2) When Aeronautical Equipment Service Records (AESR), Module Service Records (MSR), Equipment History Records (EHR),

or Scheduled Removal Component (SRC) cards exist for warranted equipment, warranty information shall be marked in the same manner as delineated in the previous Paragraph.

(3) For supplies accepted conditionally, or under special Conditions, the applicable logbook record documents shall specify any exceptions to acceptance, including work to be completed, material to be installed, and defects or non-conformances to be corrected.

(4) All equipment items, not covered by the above logbook record cards, shall have a warranty label affixed to/or part of the equipment identification plate. It shall be a bold/bright color easily identifiable and accessible to the user. Information shall be indelible. legible and contain as a minimum, the following:

(i) **"WARRANTED ITEM"**: in bold letters at least twice as large as other information;

(ii) Expiration of warranty. (Note: Guidance previously delineated in above marking paragraphs shall be followed).

(5) All shipping containers shall be marked in accordance with MIL-STD-129

(h) LIABILITY:

(1) The limitation rights and coverage set out in this warranty shall govern the liability and rights of the items for warranted failures during the Period of warranted coverage of items. Rights/liabilities granted in limitation of liability clauses in FAR 52.246 shall be given full effect when warranty coverage expires or is inapplicable. Except as Otherwise Provided in FAR 52.246, items returned to the contractor are governed by government property clause in FAR 52.245 except the loss, damage, or destruction of warranted items caused by and occurring during rework, repair, or retest shall remain the responsibility of the Contractor.

(2) Contractors liability for resultant damage shall be limited to warranted resultant damage as defined herein.

(3) LIMITATION OF LIABILITY: Contractor's total liability under this warranty shall not exceed ***[fill in amount]***.

(i) EXCLUSIONS:

(1) The Contractor shall have no Obligation to Provide warranty remedies with respect to any supplies warranted

hereunder to the extent that the defect arises or results from:

(i) Foreign Object damage (FOD), unless ingested at Contractor's plant;

(ii) Battle damage or combat damage;

(iii) Acts of sabotage or vandalism;

(iv) Acts of God; such as flood, hurricane, tornado, earthquake, lightning, etc.,

(v) Aircraft crash, hard landing, or any fire, accident or explosion where such event is not caused by a warranted defect in an item;

(vi) Improper Government or third party transportation, storage, handling, inspection, maintenance, repair, alteration, operation, installation, overhaul or replacement;

(vii) Experimental tests as applied to the engine or aircraft which would cause the engine to exceed the performance specifications;

(viii) Operation of the engine or aircraft outside of intended use or flight envelope as defined in the engine specifications.

(ix) Items, components, modules or subassemblies or any other products or supplies not acquired or procured directly from the Contractor;

(x) Erosion (including sand, volcanic ash) or corrosion (including hot corrosion) in excess of the engine specification not due to defects in material and workmanship.

(xi) Electro-Magnetic Interference beyond the engine specification requirements.

(2) Contractor's warranty shall not extend to cover:

(i) Replacement of consumables during routine operational maintenance of the engine.

(ii) Items, components, modules, subassemblies or any other products or supplies not acquired or procured directly from the Contractor (break-out parts).

(j) <u>DISCLAIMERS:</u>

(1) This warranty is for the benefit of the Government alone and is not transferable to third parties without the written agreement of the Contractor.

(2) The Contractor's liability for costs and repair is conditioned upon availability and rent-free use of facilities, tooling, and equipment identified in any Government Furnished Property - Rent Free Use provisions of this contract. Any decrease, substitution or withdrawal of said property may entitle the Contractor to an equitable adjustment.

(3) The rights and remedies of the Government and Contractor provided in this clause are in addition to, and do not limit, any rights and remedies the Government and Contractor may have under any other clause or provision of this contract.

(4) The Government's rights under this contract because of latent defects, fraud, or such gross mistakes as amount to fraud are not limited by this clause.

(5) The warranties expressed herein are in lieu of any implied warranty of MERCHANTABILITY or fitness for a particular purpose.

APPENDIX D GLENN BILL S. 1587

Subtitle E—Administration of Contract Provisions Relating to Price, Delivery, and Product Quality

PART I—ARMED SERVICES ACQUISITIONS

SEC. 2401. PROCUREMENT OF CRITICAL AIRCRAFT AND SHIP SPARE PARTS; QUALITY CONTROL.

(a) REPEAL.—Section 2383 of title 10, United States Code, is repealed.

(b) CLERICAL AMENDMENT.—The table of sections at the beginning of chapter 141 of such title is amended by striking out the item relating to section 2383.

SEC. 2402. CONTRACTOR GUARANTEES REGARDING WEAPON SYSTEMS.

Section 2403(h) of title 10, United States Code, is amended—

(1) by redesignating paragraph (2) as paragraph (3); and

(2) by inserting after paragraph (1) the following new paragraph (2):

"(2) The regulations shall include the following:

"(A) Guidelines for negotiating contractor guarantees that are reasonable and cost effective, as determined on the basis of the likelihood of defects and the estimated cost of correcting such defects.

"(B) Procedures for administering contractor guarantees.

"(C) Guidelines for determining the cases in which it may be appropriate to waive the requirements of this section.".

SEC. 2403. REPEAL OF REQUIREMENT FOR COMPLETE DELIVERY OF SUBSISTENCE SUPPLIES AT SPECIFIC PLACE UPON INSPECTION.

(a) ARMY CONTRACTS.—

(1) REPEAL.—Section 4534 of title 10, United States Code, is repealed.

(2) CLERICAL AMENDMENT.—The table of sections at the beginning of chapter 433 of such title is amended by striking out the item relating to section 4534.

(b) AIR FORCE CONTRACTS.—

(1) REPEAL.—Section 9534 of title 10, United States Code, is repealed.

(2) CLERICAL AMENDMENT.—The table of sections at the beginning of chapter 933 of such title is amended by striking out the item relating to section 9534.

APPENDIX E FAR SECTION 46.7

under the inspection provisions of the contract be prejudiced.

46.505 Transfer of title and risk of loss.

(a) Title to supplies shall pass to the Government upon formal acceptance, regardless of when or where the Government takes physical possession, unless the contract specifically provides for earlier passage of title.

(b) Unless the contract specifically provides otherwise, risk of loss of or damage to supplies shall remain with the contractor until, and shall pass to the Government upon—

(1) Delivery of the supplies to a carrier if transportation is f.o.b. origin; or

(2) Acceptance by the Government or delivery of the supplies to the Government at the destination specified in the contract, whichever is later, if transportation is f.o.b. destination.

(c) Paragraph (b) above shall not apply to supplies that so fail to conform to contract requirements as to give a right of rejection. The risk of loss of or damage to such nonconforming supplies remains with the contractor until cure or acceptance. After cure or acceptance, paragraph (b) above shall apply.

(d) Under paragraph (b) above, the contractor shall not be liable for loss of or damage to supplies caused by the negligence of officers, agents, or employees of the Government acting within the scope of their employment.

(e) The policy expressed in (a) through (d) above is specified in the clause at 52.246-16, Responsibility for Supplies, which is prescribed in 46.316.

SUBPART 46.6—MATERIAL INSPECTION AND RECEIVING REPORTS

Agencies shall prescribe procedures and instructions for the use, preparation, and distribution of material inspection and receiving reports and commercial shipping document/packing lists to evidence Government inspection (see 46.401) and acceptance (see 46.501).

SUBPART 46.7—WARRANTIES

46.701 Definitions.

"Acceptance" (see 46.101).

"Correction," as used in this subpart, means the elimination of a defect.

"Warranty," as used in this subpart, means a promise or affirmation given by a contractor to the Government regarding the nature, usefulness, or condition of the supplies or performance of services furnished under the contract.

46.702 General.

(a) The principal purposes of a warranty in a Government contract are (1) to delineate the rights and obligations of the contractor and the Government for defective items and services and (2) to foster quality performance.

(b) Generally, a warranty should provide—

(1) A contractual right for the correction of defects notwithstanding any other requirement of the contract pertaining to acceptance of the supplies or services by the Government; and

(2) A stated period of time or use, or the occurrence of a specified event, after acceptance by the Government to assert a contractual right for the correction of defects.

(c) The benefits to be derived from a warranty must be commensurate with the cost of the warranty to the Government.

46.703 Criteria for use of warranties.

The use of warranties is not mandatory. In determining whether a warranty is appropriate for a specific acquisition, the contracting officer shall consider the following factors:

(a) *Nature and use of the supplies or services.* This includes such factors as—

(1) Complexity and function;

(2) Degree of development;

(3) State of the art;

(4) End use;

(5) Difficulty in detecting defects before acceptance; and

(6) Potential harm to the Government if the item is defective.

(b) *Cost.* Warranty costs arise from—

(1) The contractor's charge for accepting the deferred liability created by the warranty; and

(2) Government administration and enforcement of the warranty (see paragraph (c) below).

(c) *Administration and enforcement.* The Government's ability to enforce the warranty is essential to the effectiveness of any warranty. There must be some assurance that an adequate administrative system for reporting defects exists or can be established. The adequacy of a reporting system may depend upon such factors as the—

(1) Nature and complexity of the item;

(2) Location and proposed use of the item;

(3) Storage time for the item;

(4) Distance of the using activity from the source of the item;

(5) Difficulty in establishing existence of defects; and

(6) Difficulty in tracing responsibility for defects.

(d) *Trade practice.* In many instances an item is customarily warranted in the trade, and, as a result of that practice, the cost of an item to the Government will be the same whether or not a warranty is included. In those instances, it would be in the Government's interest to include such a warranty.

(e) *Reduced requirements.* The contractor's charge for

assumption of added liability may be partially or completely offset by reducing the Government's contract quality assurance requirements where the warranty provides adequate assurance of a satisfactory product.

46.704 Authority for use of warranties.

The use of a warranty in an acquisition shall be approved in accordance with agency procedures.

46.705 Limitations.

(a) Except for the warranties in the clauses at 52.246-3, Inspection of Supplies—Cost-Reimbursement, and 52.246-8, Inspection of Research and Development—Cost-Reimbursement, the contracting officer shall not include warranties in cost-reimbursement contracts, unless authorized in accordance with agency regulations (see 46.708).

(b) Warranty clauses shall not limit the Government's rights under an inspection clause (see Subpart 46.3) in relation to latent defects, fraud, or gross mistakes that amount to fraud.

(c) Except for warranty clauses in construction contracts, warranty clauses shall provide that the warranty applies notwithstanding inspection and acceptance or other clauses or terms of the contract.

46.706 Warranty terms and conditions.

(a) To facilitate the pricing and enforcement of warranties, the contracting officer shall ensure that warranties clearly state the—

(1) Exact nature of the item and its components and characteristics that the contractor warrants;

(2) Extent of the contractor's warranty including all of the contractor's obligations to the Government for breach of warranty;

(3) Specific remedies available to the Government; and

(4) Scope and duration of the warranty.

(b) The contracting officer shall consider the following guidelines when preparing warranty terms and conditions:

(1) *Extent of contractor obligations.* (i) Generally, the contractor's obligations under warranties extend to all defects discovered during the warranty period, but do not include damage caused by the Government. When a warranty for the entire item is not advisable, a warranty may be required for a particular aspect of the item that may require special protection (e.g., installation, components, accessories, subassemblies, preservation, packaging, and packing, etc.).

(ii) If the Government specifies the design of the end item and its measurements, tolerances, materials, tests, or inspection requirements, the contractor's obligations for correction of defects shall usually be limited to defects in material and workmanship or failure to conform to specifications. If the Government does not specify the design, the warranty extends also to the usefulness of the design.

(iii) If express warranties are included in a contract (except contracts for commercial items), all implied warranties of merchantability and fitness for a particular purpose shall be negated by the use of specific language in the clause (see clauses 52.246-17, Warranty of Supplies of a Noncomplex Nature; 52.246-18, Warranty of Supplies of a Complex Nature; and 52.246-19, Warranty of Systems and Equipment under Performance Specifications or Design Criteria).

(2) *Remedies.* (i) Normally, a warranty shall provide as a minimum that the Government may (A) obtain an equitable adjustment of the contract, or (B) direct the contractor to repair or replace the defective items at the contractor's expense.

(ii) If it is not practical to direct the contractor to make the repair or replacement, or, because of the nature of the item, the repair or replacement does not afford an appropriate remedy to the Government, the warranty should provide alternate remedies, such as authorizing the Government to—

(A) Retain the defective item and reduce the contract price by an amount equitable under the circumstances; or

(B) Arrange for the repair or replacement of the defective item, by the Government or by another source, at the contractor's expense.

(iii) If it can be foreseen that it will not be practical to return an item to the contractor for repair, to remove it to an alternate source for repair, or to replace the defective item, the warranty should provide that the Government may repair, or require the contractor to repair, the item in place at the contractor's expense. The contract shall provide that in the circumstance where the Government is to accomplish the repair, the contractor will furnish at the place of delivery the material or parts, and the installation instructions required to successfully accomplish the repair.

(iv) Unless provided otherwise in the warranty, the contractor's obligation to repair or replace the defective item, or to agree to an equitable adjustment of the contract, shall include responsibility for the costs of furnishing all labor and material to (A) reinspect items that the Government reasonably expected to be defective, (B) accomplish the required repair or replacement of defective items, and (C) test, inspect, package, pack, and mark repaired or replaced items.

(v) If repair or replacement of defective items is required, the contractor shall generally be required by the warranty to bear the expense of transportation for returning the defective item from the place of delivery specified in the contract (irrespective of the f.o.b. point or the point of acceptance) to the contractor's plant and subsequent return. When defective items

are returned to the contractor from other than the place of delivery specified in the contract, or when the Government exercises alternate remedies, the contractor's liability for transportation charges incurred shall not exceed an amount equal to the cost of transportation by the usual commercial method of shipment between the place of delivery specified in the contract and the contractor's plant and subsequent return.

(3) *Duration of the warranty.* The time period or duration of the warranty must be clearly specified and shall be established after consideration of such factors as (i) the estimated useful life of the item, (ii) the nature of the item including storage or shelf-life, and (iii) trade practice. The period specified shall not extend the contractor's liability for patent defects beyond a reasonable time after acceptance by the Government.

(4) *Notice.* The warranty shall specify a reasonable time for furnishing notice to the contractor regarding the discovery of defects. This notice period, which shall apply to all defects discovered during the warranty period, shall be long enough to assure that the Government has adequate time to give notice to the contractor. The contracting officer shall consider the following factors when establishing the notice period:

(i) The time necessary for the Government to discover the defects.

(ii) The time reasonably required for the Government to take necessary administrative steps and make a timely report of discovery of the defects to the contractor.

(iii) The time required to discover and report defective replacements.

(5) *Markings.* The packaging and preservation requirements of the contract shall require the contractor to stamp or mark the supplies delivered or otherwise furnish notice with the supplies of the existence of the warranty. The purpose of the markings or notice is to inform Government personnel who store, stock, or use the supplies that the supplies are under warranty. Markings may be brief but should include (i) a brief statement that a warranty exists, (ii) the substance of the warranty, (iii) its duration, and (iv) who to notify if the supplies are found to be defective. For commercial items (see 46.709), the contractor's trade practice in warranty marking is acceptable if sufficient information is presented for supply personnel and users to identify warranted supplies.

(6) *Consistency.* Contracting officers shall ensure that the warranty clause and any other warranty conditions in the contract (e.g., in the specifications or an inspection clause) are consistent. To the extent practicable, all of the warranties to be contained in the contract should be expressed in the warranty clause.

46.707 Pricing aspects of fixed-price incentive contract warranties.

If a fixed-price incentive contract contains a warranty (see 46.708), the estimated cost of the warranty to the contractor should be considered in establishing the incentive target price and the ceiling price of the contract. All costs incurred, or estimated to be incurred, by the contractor in complying with the warranty shall be considered when establishing the total final price. Contractor compliance with the warranty after the establishment of the total final price shall be at no additional cost to the Government.

46.708 Warranties of data.

Warranties of data shall be developed and used in accordance with agency regulations.

46.709 Warranties of commercial items.

If a warranty of commercial items is appropriate, the contracting officer may include a warranty of supplies clause modified for commercial items (see the clause at 52.246-17, Warranty of Supplies of a Noncomplex Nature, Alternate I, and 52.246-18, Warranty of Supplies of a Complex Nature, Alternate I). More appropriate warranty language may be included if the contracting officer determines that the Government's planned usage of the item is inconsistent with the item's normal usage, or that Government specifications have substantially altered the item. The Government may adopt the contractor's standard commercial warranty if the contracting officer determines it is not inconsistent with the rights that would be afforded the Government under a warranty of supplies clause (see the clauses at 52.246-17, Warranty of Supplies of a Noncomplex Nature, and 52.246-18, Warranty of Supplies of a Complex Nature) or other terms of the contract.

46.710 Contract clauses.

The clauses and alternates prescribed in this section may be used in solicitations and contracts in which inclusion of warranty coverage is appropriate. However, because of the many situations that may influence the warranty terms and conditions appropriate to a particular acquisition, the contracting officer may vary the terms and conditions of the clauses and alternates to the extent necessary. The alternates prescribed in this section address the clauses; however, the conditions pertaining to each alternate must be considered if the terms and conditions are varied to meet a particular need.

(a)(1) The contracting officer may insert a clause substantially the same as the clause at 52.246-17, Warranty of Supplies of a Noncomplex Nature, in solicitations and contracts for noncomplex items when a fixed-price supply contract is contemplated and the use of a warranty clause has been approved under agency procedures.

(2) If commercial items are to be acquired, the contracting officer may use the clause with its Alternate I.

(3) If it is desirable to specify that necessary transportation incident to correction or replacement will be at the Government's expense (as might be the case if, for example, the cost of a warranty would otherwise be prohibitive), the contracting officer may use the clause with its Alternate II.

(4) If the supplies cannot be obtained from another source, the contracting officer may use the clause with its Alternate III.

(5) If a fixed-price incentive contract is contemplated, the contracting officer may use the clause with its Alternate IV.

(6) If it is anticipated that recovery of the warranted items will involve considerable Government expense for disassembly and/or reassembly of larger items, the contracting officer may use the clause with its Alternate V.

(b)(1) The contracting officer may insert a clause substantially the same as the clause at 52.246-18, Warranty of Supplies of a Complex Nature, in solicitations and contracts for deliverable complex items when a fixed-price supply or research and development contract is contemplated and the use of a warranty clause has been approved under agency procedures.

(2) If commercial items are to be acquired, the contracting officer may use the clause with its Alternate I.

(3) If it is desirable to specify that necessary transportation incident to correction or replacement will be at the Government's expense (as might be the case if, for example, the cost of a warranty would otherwise be prohibitive), the contracting officer may use the clause with its Alternate II.

(4) If a fixed-price incentive contract is contemplated, the contracting officer may use the clause with its Alternate III.

(5) If it is anticipated that recovery of the warranted item will involve considerable Government expense for disassembly and/or reassembly of larger items, the contracting officer may use the clause with its Alternate IV.

(c)(1) The contracting officer may insert a clause substantially the same as the clause at 52.246-19, Warranty of Systems and Equipment under Performance Specifications or Design Criteria, in solicitations and contracts when performance specifications or design are of major importance; a fixed-price supply, service, or research and development contract for systems and equipment is contemplated; and the use of a warranty clause has been approved under agency procedures.

(2) If it is desirable to specify that necessary transportation incident to correction or replacement will be at the Government's expense (as might be the case if, for example, the cost of a warranty would otherwise be prohibitive), the contracting officer may use the clause with its Alternate I.

(3) If a fixed-price incentive contract is contemplated, the contracting officer may use the clause with its Alternate II.

(4) If it is anticipated that recovery of the warranted item will involve considerable Government expense for disassembly and/or reassembly of larger items, the contracting officer may use the clause with its Alternate III.

(d) The contracting officer may insert a clause substantially the same as the clause at 52.246-20, Warranty of Services, in solicitations and contracts for services when a fixed-price contract for services is contemplated and the use of warranty clause has been approved under agency procedures; unless a clause substantially the same as the clause at 52.246-19, Warranty of Systems and Equipment under Performance Specifications or Design Criteria, has been used.

(e)(1) The contracting officer may insert a clause substantially the same as the clause at 52.246-21, Warranty of Construction, in solicitations and contracts when a fixed-price construction contract (see 46.705(c)) is contemplated and the use of a warranty clause has been approved under agency procedures.

(2) If the Government specifies in the contract the use of any equipment by "brand name and model," the contracting officer may use the clause with its Alternate I.

SUBPART 46.8—CONTRACTOR LIABILITY FOR LOSS OF OR DAMAGE TO PROPERTY OF THE GOVERNMENT

46.800 Scope of subpart.

This subpart prescribes policies and procedures for limiting contractor liability for loss of or damage to property of the Government that (a) occurs after acceptance and (b) results from defects or deficiencies in the supplies delivered or services performed.

46.801 Applicability.

(a) The subpart applies to contracts other than those for (1) automatic data processing, (2) telecommunications, (3) construction, (4) architect-engineer services and (5) maintenance and rehabilitation of real property. This subpart does not apply to items priced at or based on catalog or market prices except as indicated in 46.804.

(b) See Subpart 46.7, Warranties, for policies and procedures concerning contractor liability caused by nonconforming technical data.

46.802 Definition.

"High-value item," as used in this subpart, means a contract end item that (a) has a high unit cost (normally exceeding $100,000 per unit), such as an aircraft, an aircraft engine, a communication system, a computer system, a missile, or a ship, and (b) is designated by the contracting officer as a high-value item.

APPENDIX F DFARS SECTION 246.7

SUBPART 246.7--WARRANTIES

246.701 Definitions.

"Acceptance," as defined in FAR 46.701 and as used in this subpart and in the warranty clauses at FAR 52.246-17, Warranty of Supplies of a Noncomplex Nature; FAR 52.246-18, Warranty of Supplies of a Complex Nature; FAR 52.246-19, Warranty of Systems and Equipment Under Performance Specifications or Design Criteria; and FAR 52.246-20, Warranty of Services, includes the execution of an official document (e.g., DD Form 250, Material Inspection and Receiving Report) by an authorized representative of the Government.

"Defect," as used in this subpart, means any condition or characteristic in any supply or service furnished by the contractor under the contract that is not in compliance with the requirements of the contract.

246.702 General

(c) Departments and agencies shall establish procedures to track and accumulate data on warranty costs.

246.703 Criteria for use of warranties.

The use of warranties in the acquisition of weapon systems is mandatory (10 U.S.C. 2403) unless a waiver is authorized (see 246.770-8).

(b) *Cost.*
Contracting officers may include the cost of a warranty as part of an item's price or as a separate contract line item.

246.704 Authority for use of warranties.

The chief of the contracting office must approve use of a warranty, except in acquisitions for--

(1) Weapon systems (see 246.770);

(2) Commercial supplies or services (see FAR 46.709);

(3) Technical data, unless the warranty provides for extended liability (see 246.708);

(4) Supplies and services in fixed price type contracts containing quality assurance provisions that reference MIL-I-45208, Inspection System Requirement, or MIL-Q-9858, Quality Program Requirements; or

(5) Supplies and services in construction contracts when using the warranties that are contained in Federal, military, or construction guide specifications.

246.705 Limitations.

(a) Warranties in the clause at 252.246-7001, Warranty of Data, are also an exception to the prohibition on use of warranties in cost-reimbursement contracts.

246.706 Warranty terms and conditions.

(b)(5) *Markings.*
Use MIL Standard 129, Marking for Shipments and Storage, and MIL Standard 130, Identification Marking of U.S. Military Property, when marking warranty items.

246.708 Warranties of data.

Obtain warranties on technical data when practicable and cost effective. Consider the factors in FAR 46.703 in deciding whether to obtain warranties of technical data. Consider the following in deciding whether to use extended liability provisions--

(1) The likelihood that correction or replacement of the nonconforming data, or a price adjustment, will not give adequate protection to the Government; and

(2) The effectiveness of the additional remedy as a deterrent against furnishing nonconforming data.

246.710 Contract clauses.

(1) Use a clause substantially the same as the clause at 252.246-7001, Warranty of Data, in solicitations and contracts that include the clause at 252.227-7013, Rights in Technical Data and Computer Software, and there is a need for greater protection or period of liability than provided by other contract clauses, such as the clauses at--

(i) FAR 52.246-3, Inspection of Supplies--Cost-Reimbursement;

(ii) FAR 52.246-6, Inspection--Time-and-Material and Labor-Hour;

(iii) FAR 52.246-8, Inspection of Research and Development--Cost-Reimbursement; and

(iv) FAR 52.246-19, Warranty of Systems and Equipment Under Performance Specifications or Design Criteria.

(2) Use the clause at 252.246-7001, Warranty of Data, with its Alternate I when extended liability is desired and a fixed price incentive contract is contemplated.

(3) Use the clause at 252.246-7001, Warranty of Data, with its Alternate II when extended liability is desired and a firm fixed price contract is contemplated.

246.770 Warranties in weapon system acquisitions.

This section sets forth policies and procedures for use of warranties in contracts for weapon system production.

246.770-1 Definitions.

As used in this section--

(a) "At no additional cost to the Government" means--

(1) At no increase in price for firm fixed price contracts;

(2) At no increase in target or ceiling price for fixed price incentive contracts (see also FAR 46.707); or

(3) At no increase in estimated cost or fee for cost-reimbursement contracts.

(b) "Design and manufacturing requirements" means structural and engineering plans and manufacturing particulars, including precise measurements, tolerances, materials and finished product tests for the weapon system being produced.

(c) "Essential performance requirements" means the operating capabilities and maintenance and reliability characteristics of a weapon system that the agency head determines to be necessary to fulfill the military requirement.

(d) "Initial production quantity" means the number of units of a weapon system contracted for in the first program year of full-scale production.

(e) "Mature full-scale production" means follow-on production of a weapon system after manufacture of the lesser of the initial production quantity or one-tenth of the eventual total production quantity.

(f) "Weapon system" means a system or major subsystem used directly by the Armed Forces to carry out combat missions.

(1) The term includes, but is not limited to, the following (if intended for use in carrying out combat missions)--

(i) Tracked and wheeled combat vehicles;

(ii) Self-propelled, towed and fixed guns, howitzers and mortars;

(iii) Helicopters;

(iv) Naval vessels;

(v) Bomber, fighter, reconnaissance and electronic warfare aircraft;

(vi) Strategic and tactical missiles including launching systems;

(vii) Guided munitions;

(viii) Military surveillance, command, control, and communication systems;

(ix) Military cargo vehicles and aircraft;

(x) Mines;

(xi) Torpedoes;

(xii) Fire control systems;

(xiii) Propulsion systems;

(xiv) Electronic warfare systems: and

(xv) Safety and survival systems.

(2) The term does not include--

(i) Commercial items sold in substantial quantities to the general public (see FAR 15.804-3(c)); or

(ii) Spares, repairs, or replenishment parts; or

(iii) Related support equipment (e.g., ground-handling equipment, training devices and accessories, ammunition), unless an effective warranty would require inclusion of such items.

246.770-2 Policy.

(a) Under 10 U.S.C. 2403, departments and agencies may not contract for the production of a weapon system with a unit weapon system cost of more than $100,000 or an estimated total procurement cost in excess of $10 million unless--

(1) Each contractor for the weapon system provides the Government written warranties that--

(i) The weapon system conforms to the design and manufacturing requirements in the contract (or any modifications to that contract),

(ii) The weapon system is free from all defects in materials and workmanship at the time of acceptance or delivery as specified in the contract; and

(iii) The weapon system, if manufactured in mature full-scale production, conforms to the essential performance requirements of the contract (or any modification to that contract); and

(2) The contract terms provide that, in the event the weapon system fails to meet the terms of the above warranties, the contracting officer may--

(i) Require the contractor to promptly take necessary corrective action (e.g., repair, replace, and/or redesign) at no additional cost to the Government;

(ii) Require the contractor to pay costs reasonably incurred by the Government in taking necessary corrective action, or

(iii) Equitably reduce the contract price; or

(3) A waiver is granted under 246.770-8.

(b) Contracting officers may require warranties that provide greater coverage and remedies than specified in paragraph (a) of this subsection, such as including an essential performance requirement warranty in other than a mature full-scale production contract.

(c) When the contract includes an essential performance requirement warranty, the warranty must identify redesign as a remedy available to the Government.

(1) The period during which redesign must be available as a remedy shall not end before operational use, operational testing, or a combination of operational use and operational testing has demonstrated that the warranted item's design has satisfied the essential performance requirements.

(2) When essential performance requirements are warranted in contracts with alternate source contractors, do not include redesign as a remedy available to the Government under those contracts until the alternate source has manufactured the first ten percent of the eventual total production quantity anticipated to be acquired from that contractor (see 246.770-5).

246.770-3 Tailoring warranty terms and conditions.

(a) Since the objectives and circumstances vary considerably among weapon system acquisition programs, contracting officers must tailor the required warranties on a case-by-case basis. The purpose of tailoring is to get a cost-effective warranty in light of the technical risk, or other program uncertainties, while ensuring that the Government still acquires the basic warranties described in 246.770-2. Tailoring shall not be used as a substitute for acquiring a warranty waiver.

(1) Tailoring may affect remedies, exclusions, limitations, and duration provided such are consistent with the specific requirements of this section (see also FAR 46.706).

(2) Clearly relate the duration of any warranty to the contract requirements and allow sufficient time to demonstrate achievement of the requirements after acceptance.

(3) Tailor the terms of the warranty, if appropriate, to exclude certain defects for specified supplies (exclusions) or to limit the contractor's liability under the terms of the warranty (limitations).

(4) Structure broader and more comprehensive warranties when advantageous or narrow the scope when appropriate. For example, it may be inappropriate to require warranty of all essential performance requirements for a contractor that did not design the system.

(b) DoD policy is to exclude any terms that cover contractor liability for loss, damage, or injury to third parties from warranty clauses.

(c) Ensure acquisition of subsystems and components in a manner which does not affect the validity of the weapon system warranty.

246.770-4 Warranties on Government-furnished property.

Contracting officers shall not require contractors to provide the warranties specified in 246.770-2 on any property furnished the contractor by the Government, except for--

(a) Defects in installation;

(b) Installation or modification in such a manner that invalidates a warranty provided by the manufacturer of the property; or

(c) Modifications made to the property by the contractor.

246.770-5 Exemption for alternate source contractor(s).

Agency heads may exempt alternate source contractor(s) from the essential performance warranty requirements of 246.770-2(a)(1)(iii) until that contractor manufactures the first ten percent of its anticipated total production quantity.

246.770-6 Applicability to foreign military sales (FMS).

(a) The warranty requirements of 246.770-2 are not mandatory for FMS production contracts. DoD policy is to obtain the same warranties on conformance to design and manufacturing requirements and against defects in material and workmanship as it gets for U.S. supplies.

(b) DoD normally will not obtain essential performance warranties for FMS purchasers. However, where contracting officer cannot separately identify the cost for the warranty of essential performance requirements, the foreign purchaser shall be given the same warranty that the United States gets.

(c) If an FMS purchaser expressly requests a performance warranty in the letter of acceptance, the Government will exert its best efforts to obtain the same warranty obtained for U.S. equipment. Or, if specifically requested by the FMS purchaser, obtain a unique warranty.

(d) The costs for warranties for FMS purchasers may be different from the costs for such warranties for the Government due to factors such as overseas transportation and any tailoring to reflect the unique aspects of the FMS purchaser.

(e) Ensure that FMS purchasers bear all of the acquisition and administrative costs of any warranties.

246.770-7 Cost-benefit analysis.

(a) In assessing the cost effectiveness of a proposed warranty, perform an analysis which considers both the quantitative and qualitative costs and benefits of the warranty. Consider--

(1) Costs of warranty acquisition, administration, enforcement, and user costs, and any costs resulting from limitations imposed by the warranty provisions;

(2) Costs incurred during development specifically for the purpose of reducing production warranty risks;

(3) Logistical and operational benefits as a result of the warranty as well as the impact of the additional contractor motivation provided by the warranty.

(b) Where possible, make a comparison with the costs of obtaining and enforcing similar warranties on similar systems.

(c) Document the analysis in the contract file. If the warranty is not cost effective, initiate a waiver request under 246.770-8.

246.770-8 Waiver and notification procedures.

(a) The Secretary of Defense has delegated waiver authority within the limits specified in 10 U.S.C. 2403. The waiving authority for the defense agencies is the Assistant Secretary of Defense (Production and Logistics). The waiving authority for the military departments is the Secretary of the department with authority to redelegate no lower than an Assistant Secretary. The waiving authority may waive one or more of the weapons system warranties required by 246.770-2 if--

(1) The waiver is in the interests of national defense; or

(2) The warranty would not be cost effective.

(b) Waiving authorities must make the following notifications or reports to the Senate and House Committees on Armed Services and Appropriations for all waivers--

(1) *Major Weapon Systems.*
For a weapon system that is a major defense acquisition program for the purpose of 10 U.S.C. 2432, the waiving official must notify the Committees in writing of an intention to waive one or more of the required warranties. Include an explanation of the reasons for the waiver in the notice. Ordinarily provide the notice 30 days before granting a waiver.

(2) *Other Weapon Systems.*
For weapon systems that are not major defense acquisition programs for the purpose of 10 U.S.C. 2432, waiving officials must submit an annual report not later than February 1 of each year. List the waivers granted in the preceding calendar year in the report and include an explanation of the reasons for granting each waiver.

(3) *Weapon Systems Not in Mature Full-Scale Production.*
Although a waiver is not required, if a production contract for a major weapon system not yet in mature full-scale production will not include a warranty on essential performance requirements, the waiving officials must comply with the notice requirements for major weapon systems.

(c) Departments and agencies shall issue procedures for processing waivers, notifications, and reports to Congress.

(1) Requests for waiver shall include--

(i) A brief description of the weapon system and its stage of production, e.g., the number of units delivered and anticipated to be delivered during the life of the program;

(ii) Identification of the specific warranty or warranties required by 246.770-2(a)(1) for which the waiver is requested;

(iii) The duration of the waiver if it is to go beyond the contract;

(iv) The rationale for the waiver (if the waiver request is based on cost-effectiveness, include the results of the cost-benefit analysis);

(v) A description of the warranties or other techniques used to ensure acceptable field performance of the weapon system, e.g., warranties, commercial or other guarantees obtained on individual components; and

(vi) Exercise date of the warranty option, if applicable.

(2) Notifications and reports shall include--

(i) A brief description of the weapon system and its stage of production; and

(ii) Rationale for not obtaining a warranty.

(3) Keep a written record of each waiver granted and notification and report made, together with supporting documentation such as a cost-benefit analysis, for use in answering inquiries.

APPENDIX G SECNAVINST 4330.17

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20350-1000

SECNAVINST 4330.17
S0-4 (CBM)
18 SEP 1987

SECNAV INSTRUCTION 4330.17

From: Secretary of the Navy

Subj: NAVY POLICY ON USE OF WARRANTIES

Ref: (a) Navy Acquisition Regulations Supplement (NARSUP) SUBPART 46.72
(b) Federal Acquisition Regulation (FAR) SUBPART 46.7
(c) DoD FAR Supplement (DFARS) SUBPART 46.7

1. Purpose. To ensure that the Department of Navy (DON) obtains and administers warranties that enhance the quality, reliability and performance of systems, subsystems and materials.

2. Scope. This instruction applies to all Fleet, Fleet Marine Force and Shore activities involved in logistics support for DON systems, subsystems and materials.

3. Policy. It is DON Policy to:

a. Ensure that Navy obtains warranties for:

(1) all weapons systems used directly by the armed forces. This applies to weapons systems which will have a unit cost greater than $100,000, or for which the eventual total procurement cost will be more than $10,000,000, unless such warranties are determined not to be cost effective.

(2) all other supplies and services (i.e., non-weapons systems), when the contracting officer determines that obtaining a warranty is advantageous to the Government. Such warranties must equal or exceed the requirements of DFARS 46.770.

b. Ensure that Systems are established for:

(1) reporting failed items under warranty

(2) user return of warranted products

(3) collecting and analyzing actual warranty use and claim data

4. Action. Addressees will implement and provide copies of implementing instructions to ASN (Shipbuilding and Logistics) Contract Business Management within 120 days. Detailed directives should address the issues presented in reference (a).

a. The Chief of Naval Operations will:

(1) establish procedures to ensure that warranties are obtained for:

(a) weapons systems meeting the thresholds specified here.

(b) all other supplies and services (i.e., non-weapons systems) per references (b) and (c).

(2) establish procedures to ensure maximum use of warranted products before expiration of the warranty periods.

(3) establish a customer/user notification system which provides for feedback information on failed items under warranty, minimizing reporting requirements of fleet activities and maintenance personnel.

(4) develop procedures for immediate issuance of credit to the end item user, when appropriate, when requisitioned products under warranty are found to be defective upon installation.

(5) develop a system for collecting actual warranty use and claim data, and for performing an analysis of the data on an annual basis with the first analysis to be performed on 30 June following implementation of this instruction, and annually each June thereafter. Provide copies of annual warranty data analyses to the Assistant Secretary of the Navy (Shipbuilding & Logistics) (ASN(S&L)) within 60 days of the end of each annual analysis period.

b. The Commandant of the Marine Corps will develop warranty policy for Marine Corps acquisitions, and establish procedures for processing warranty claims.

c. The Comptroller of the Navy will ensure that procedures are available to collect funds under warranties and that those funds are properly credited to the appropriate accounts.

Everett Pyatt

EVERETT PYATT
ASSISTANT SECRETARY OF THE NAVY
(SHIPBUILDING AND LOGISTICS)

Distribution:
SNDL A2A (NAVCOMPT, OGC)
A3 (Chief of Naval Operations)
A6 (Headquarters, U. S. Marine Corps)

Copy to:
SNDL A1 (Assistant Secretary of the Navy (Shipbuilding and Logistics))
(Assistant Secretary of the Navy (Financial Management))

Copy to (cont'd):
SNDL FL1 (Naval Data Automation Command)(Code-813, only)
(20 copies)

Stocked:
CO, NAVPUBFORMCEN
5801 Tabor Avenue
Philadelphia, PA 19120-5099 (100 copies)

APPENDIX H NAVAIRINST 13070.7

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
NAVAL AIR SYSTEMS COMMAND HEADQUARTERS
WASHINGTON, DC 20361-0001

IN REPLY REFER TO
NAVAIRINST 13070.7
AIR-516
9 Dec 85

NAVAIR INSTRUCTION 13070.7

From: Commander, Naval Air Systems Command

Subj: POLICY GUIDANCE FOR WARRANTY APPLICATION ON NAVAL AIR SYSTEMS COMMAND WEAPON SYSTEM PROCUREMENTS

Ref: (a) Section 794, Public Law 98-212
(b) Section 2403, Title 10, United States Code
(c) DoD Federal Acquisition Regulation Supplement 46.770, Use of Warranties in Weapon System Procurements

1. Purpose. To set forth objectives, establish policies, and assign responsibilities for the application of warranty provisions as part of contracts for the development, production, and modification of Naval Air Systems Command (NAVAIR) weapon systems in compliance with references (a), (b), and (c).

2. Scope. This instruction applies to all echelons of command and all weapon systems under the management control of the Commander, Naval Air Systems Command (COMNAVAIR).

3. Objectives. To ensure that each weapon system and subsystem contract contains warranties covering design and manufacturing requirements, defects in materials and workmanship, and essential performance requirements which will provide NAVAIR with sufficient time after delivery to determine that the weapon systems and subsystems have indeed achieved requirements specified in the contract and are free from defects in materials and workmanship.

4. Policy. It is the policy of COMNAVAIR in complying with referenced legislation to:

a. Obtain warranties on weapon systems following the provisions of reference (c), unless it is determined that the warranties are not cost effective or are not in the best interest of the Government. In assessing the best interests of the Government, ensure that fleet readiness and mission effectiveness are given the highest priority. If it can be shown that a warranty is not cost effective or is not in the best interest of the Government, a waiver should be requested following reference (c).

b. Ensure that all weapon system warranties contain provisions requiring the contractor to furnish data on warranty repairs.

c. Ensure that all acquisition plans address the planned use of warranties and their associated impact on fleet user maintenance operations and the NAVAIR logistics support system.

d. Ensure that methods are established to identify all warranted items, including marking both warranted material and shipping containers as appropriate.

e. Ensure that the time period of warranty coverage is clearly established, is reasonable, and is sufficient to cover the types of defects and nonconformances that are likely to occur during service use.

5. Responsibilities

a. Naval Air Systems Command Headquarters (NAVAIRHQ)

(1) Assistant Commander for Systems and Engineering (AIR-05) will exercise overall management and administrative control of NAVAIR warranty programs by performing the following functions:

(a) Serve as principal spokesman and contact within NAVAIRHQ, and coordinator throughout NAVAIR, for all matters related to weapon system warranties.

(b) Provide technical advice, guidance, and general interpretations concerning warranty applications to all requiring NAVAIRHQ divisions.

(c) Provide a capability through the Cost Analysis Division (AIR-524) for warranty life cycle cost analysis.

(d) Maintain a general overview of Navy warranty applications, making independent evaluations in order to assess the net benefits of each warranty to the Navy.

(e) Serve as the NAVAIR spokesman to higher levels on warranties as required.

(f) Serve as the coordinating agent with the Secretary of the Navy (SECNAV) and the Secretary of Defense, or their designated representatives, for the processing and approval of all warranty waiver requests on NAVAIR weapon systems or subsystems.

(2) Assistant Commander for Logistics/Fleet Support (AIR-04) will provide administrative services, training, advice, and guidance on matters involving warranties. These responsibilities will encompass the following functions:

(a) Establish a single point of contact within AIR-04 for matters involving warranties.

(b) Provide advice and guidance on warranty applicability, in matters relating to weapon systems or subsystems maintenance, modifications, and repairs.

(c) Provide requirements on matters pertaining to logistics support and maintenance engineering for the transition of warranted equipment from development to production and also for the transition to Navy organic support.

(d) Perform analyses of all NAVAIR warranties with respect to economics and logistic support impacts.

(e) Provide for the logistic support analysis process to determine the impact of proposed warranties before issuance of the maintenance plan as required by NAVAIR Instruction 4790.4A.

(f) When a NAVAIR weapon system warranty is incorporated in a contract, ensure integration of that warranty into the appropriate weapon system maintenance plan.

(g) Ensure that warranty provisions are considered in all logistics planning actions.

(h) Establish an effective fleet data feedback system to support the administration of all NAVAIR procurement warranty programs.

(i) Develop and provide a training program for logistics support and fleet user personnel on the proper implementation and administration of warranty programs.

(3) Assistant Commander for Contracts (AIR-02) will

(a) provide advice and guidance in the development of contractual warranty provisions for NAVAIR weapon system procurement programs;

(b) establish procedures to track and accumulate data relative to warranty costs;

(c) ensure proper and complete coverage of warranty requirements in all NAVAIR contractual documents associated with the procurement of NAVAIR weapon systems; and

(d) act as the prime point of contact with contractors on contractual matters relating to weapon system warranty provisions.

(4) Office of Counsel (AIR-00C) will review all warranty clauses and related contract wording for proper form and legal sufficiency.

(5) Comptroller (AIR-08) will provide advice and assistance to program and logistics managers in budgeting for and justifying funding in support of warranty applications prior to the execution of a contract involving warranties.

(6) Cognizant program manager or coordinator will

(a) plan and budget for warranty applications unless SECNAV has determined that the warranty is not advantageous to the Navy;

(b) be the final authority within NAVAIRHQ for evaluation of warranties as they affect their program with particular emphasis on the period of the warranty and, where applicable, the essential performance requirements that must be warranted;

(c) if deemed necessary, following coordination with AIR-02 and AIR-05, make a final recommendation through the appropriate Navy chain of command to request a waiver of warranty provisions in contracts pertaining to their program; and

(d) review and determine the effectiveness of warranty provisions on their program in terms of warranty costs and improvements to fleet readiness and mission effectiveness.

b. NAVAIR Field Activities and Inventory Control Points (ICPs). Heads of NAVAIR field activities and ICP directors and officers who execute or are the procuring activity for contracts that purchase or modify NAVAIR material will be responsible for administering, budgeting, funding, and applying warranty provisions which meet the intent of this instruction in all purchase actions and requests.

c. Naval Aviation Logistics Center will provide advice and guidance regarding warranty applications to naval air rework facilities or other depot maintenance activities as they become involved in the program. These activities should be coordinated with AIR-05, AIR-04, and AIR-02.

6. Action

a. Addressees will

(1) take action to implement the provisions of this instruction, which incorporates direction provided by reference (c) effective 2 January 1985, on all new procurements and equipment modification contracts;

(2) in those cases where evaluation indicates that the application of a warranty as required under references (a), (b), and (c), is not advantageous to the Navy, participate in the

preparation of a waiver request, with a detailed written justification attached, for submittal to SECNAV or the designated Assistant Secretary, via the chain of command; and

(3) take action to evaluate cognizant NAVAIR instructions and military standards and revise them as appropriate for compatibility with this instruction.

b. When a NAVAIR weapon system or subsystem (including support equipment) has been selected for warranty application, the cognizant acquisition manager (NAVAIRHQ, field activity, or ICP) will so apprise AIR-05 and provide AIR-05 with a copy of the proposed contract warranty clause(s).

R. V. JOHNSON
Deputy Commander

Distribution: FKA1A (established quantity, others 5 copies each)
SNDL: FKA1A (Deputy Commanders, Assistant Commanders, Comptroller, Command Special Assistants, Designated Program Managers, Program Coordinators, and Office and Division Directors); FKA1E; FKA6A1; FKA6A2; FKP1H; FKM13; FKM15; FKR2; FKR3; FKR5; FKR7

Copy to: (2 copies each unless otherwise indicated)
SNDL: [illegible]; [illegible] (NPPSDO, NDW C/L); [illegible] (Morgantown (1 copy)); FKA1 (less FKA1A); FKA1A (AIR-07D21 A/L (1 copy), AIR-7221 (10 copies), AIR-[illegible] (40 copies), AIR-5165 (10 copies))

Stocked: Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099

APPENDIX I ASN POLICY MEMORANDUM

SEP 8 1986

MEMORANDUM FOR THE COMMANDERS OF NAVAL SYSTEMS COMMANDS
DEPUTY CHIEF OF STAFF FOR INSTALLATIONS
AND LOGISTICS, HEADQUARTERS, U.S. MARINE CORPS
DIRECTOR, STRATEGIC SYSTEMS PROJECT OFFICE
CHIEF OF NAVAL RESEARCH
COMMANDER, MILITARY SEALIFT COMMAND

Subj: WARRANTIES

Ref: (a) DoD FAR Supplement (DFARS), Subpart 46.7
(b) Federal Acquisition Regulation (FAR) 31.205-39
(c) Federal Acquisition Regulation (FAR) 46.707

The use of warranties in the procurement of weapon systems is mandatory when items that can be used directly by the Navy to carry out combat missions meet the thresholds established in reference (a).

The basic elements of these warranties are as follows:

- Conformance to design and manufacturing requirements
- Freedom from defects in materials and workmanship
- Conformance to essential performance requirements

The same elements of written warranties are the basic expectations with which we enter development and production contracts. The contractor should be developing the item to meet the performance requirements. A quality system should exist to assure conformance to design and freedom from defects in manufacture and workmanship. It follows that we should expect contractors to meet their obligations without the need to negotiate additional warranty costs.

While it is not appropriate to negotiate additional cost for a warranty under these conditions, it may be reasonable to

consider through additional profit the added risk to a contractor for costs which may be incurred in satisfying the conditions of a warranty. The degree of risk will be related to the complexity of the design and manufacturing requirements and the difficulty in meeting essential performance requirements. The risk associated with a warranty must be quantified and documented in business clearances.

It is recognized that under certain unusual circumstances contractors could not have satisfied warranty responsibilities in the design, development, and production contracts. Examples may include warranties exceeding specification requirements or cases in which the contractor was not involved in design and development. In these cases, it may be appropriate to negotiate additional warranty costs. Warranty costs must be evaluated and the cost/benefit analysis should be documented in business clearances.

The provisions of references (b) and (c) should be followed in implementing this policy which is effective for all procurements for which approval or clearance has not been obtained.

EVERETT PYATT
ASSISTANT SECRETARY OF THE NAVY
(SHIPBUILDING AND LOGISTICS)

APPENDIX J NAVAIR NOTICE 4855

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
NAVAL AIR SYSTEMS COMMAND HEADQUARTERS
WASHINGTON, DC 20361-0001

Canc frp: May 90
IN REPLY REFER TO
NAVAIRNOTE 4855
AIR-516
17 May 89

NAVAIR NOTICE 4855

From: Commander, Naval Air Systems Command

Subj: WARRANTY GUIDANCE

Ref: (a) NAVAIRINST 13070.7 of 9 Dec 85
(b) Section 2403, Title 10, United States Code
(c) Federal Acquisition Regulation Subpart 46.7
(d) DOD Federal Acquisition Regulation Supplement, Subpart 246.7
(e) NARSUP 46.702
(f) SECNAVINST 4330.17 of 18 Sep 87
(g) SECNAV memo of 3 Sep 86

Encl: (1) NAVAIR Warranty Administration Program Approach For OPNAV Instruction 4790.2D Items (Aircraft and Aircraft Equipment)
(2) NAVAIR Warranty Product Line Subgroup Leaders
(3) Form NAVAIR 13070/1, NAVAIR Warranty Appliction Checklist

1. Purpose. To clarify the warranty policies and responsibilities of reference (a). This notice is intended to complement, not replace, reference (a).

2. Background. Reference (a) established the Naval Air Systems Command (NAVAIR) warranty policy as a result of references (b) and (c). This notice incorporates the provisions of references (d) and (e) that were issued subsequent to reference (a) as well as refinements and clarifications that have evolved as the NAVAIR warranty program has matured. (It does not provide the detail language required in a warranty. That guidance will be provided by subsequent generic warranty provisions and approach documentation.) To implement reference (a), consistent and nonintrusive methods of administering warranties for NAVAIR equipment in the fleet are required and those methods must be reflected in the warranty language. Fleet warranty processing procedures for aircraft/aircraft equipment and airborne weapon systems are delineated in OPNAV Instruction 4790.2D (and described in enclosure (1)) and OPNAV Instruction 8500.2 respectively.

3. Policy. The policy of the Commander, Naval Air Systems Command, in addition to reference (a), is to:

a. Obtain warranties on all items where the cost benefit analysis demonstrates a warranty to be cost effective or otherwise in the best interest of the Navy. The results of the cost benefit analysis will be placed in the contract files.

b. Minimize the burden to the fleet resulting from warranty administration by using existing reporting systems to the maximum extent possible.

c. Subject to organic repair capability, permit organic repair without voiding the warranty. The warranty will embrace NAVAIR's maintenance philosophy/approach.

d. Pursue a no cost warranty per reference (f).

e. Identify warranted items by individual marking and/or a notation in the item's logbook. Marking, as a minimum must include the statement "WARRANTY ITEM", expiration of the warranty, contract number, and where to ship while under warranty if location is other than that indicated by the Master Repairable Index List (MRIL). Containers will be marked per MIL-STD-129J, appendix C, paragraph 20.23.

f. The duration of the warranty period will be a minimum of one year in-service. Warranty duration/administration methods must consider anticipated lead time/shelf time required for Government Furnished Equipment (GFE)/spares to be incorporated into a delivered end item.

3. Responsibilities. The following provides clarification of selected responsibilities as stated in reference (a) paragraph 5:

a. Assistant Commander for Systems and Engineering (AIR-05)

(1) Product Integrity Management Division (AIR-516) will:

(a) Exercise overall management of the NAVAIR warranty program. AIR-516 will chair the NAVAIR Warranty Policy Committee (NWPC). The NWPC, which consists of the warranty points of contact for AIR-05, the Assistant Commander for Fleet Support and Field Activity Management (AIR-04), the Assistant Commander for Contracts (AIR-02), the NAVAIR Acquisition Executive and Deputy Commander for Operations (AIR-01), and the Office of Counsel (AIR-00C), is an advisory group that will develop policies/implementing procedures and provide Command guidance.

(b) Periodically review warranties in Procurement Requests (PR's) to assess compliance with Command policy and to identify adjustments to the warranty program as needed.

(2) AIR-05 divisions will assign/select warranty subgroup leaders and monitor subgroup activity. Subgroups will include AIR-04 and AIR-02 representation. The subgroups will be organized along product lines, as described in enclosure (2). The subgroup will develop, maintain, and ensure the appropriate application of generic warranty approaches, support Program Managers during warranty development, and review PR's using the enclosure (3) warranty application checklist to ensure compliance with NAVAIR warranty policy. The subgroup leaders will obtain approval from the NWPC for the generic warranty approaches and will provide feedback to the NWPC with regard to the effectiveness of the generic warranty approaches and Command policy/procedures.

b. AIR-03

(1) Logistics and Maintenance Policy Division (AIR-411) will participate on the NWPC, act as the main focal point on all warranty policies and issues that apply to logistics and maintenance procedures, and provide advice and guidance to the Assistant Program Manager for Logistics (APML)/Logistics Manager (LM), field activity, and fleet personnel regarding warranty administration procedures.

(2) Supply Policy, Management and Financial Programs Division (AIR-412) will implement policies and procedures related to interim initial/replenishment spares.

(3) Product Support Directorates (PSD) and Product Support Advocates (PSA) will perform the functions assigned in reference (a), paragraph 5c, by providing advice and guidance regarding warranty applications on programs under their cognizance. These activities will submit their efforts through AIR-411 and the appropriate Product Support Program Office (AIR-41P) and the Deputy Assistant Commander for Aviation Depots (AIR-43) point of contact for coordination with the NWPC and the cognizant program manager.

(4) APML/LM will ensure that the maintenance plan, technical manuals, and all appropriate documents contain warranty information necessary to provide sufficient guidance for effective administration.

c. AIR-02

(1) Policy and Management Division (AIR-211) will participate on the NWPC, coordinate AIR-02 warranty policy, and advise the Principal Contracting Officers (PCO's) regarding warranty implementing procedures.

(2) PCO's or their duly authorized representative will negotiate and contractually administer the warranty and any resulting remedies.

d. AIR-00C will participate on the NWPC, coordinate AIR-00C warranty policy, and establish Command procedures for ensuring compliance with statutory and regulatory requirements.

e. AIR-01

(1) NAVPRO Management Division (AIR-119) will participate on the NWPC, provide guidance, and coordinate warranty policy and implementing procedures with all contract administration services.

(2) Cognizant Program Managers will:

(a) Ensure that a warranty cost benefit analysis is performed with advice provided by the Cost Analysis Division (AIR-524) as supported by the administration contracting offices (ACO's) and PCO, and the results of the cost benefit analysis are provided to the PCO for inclusion in the contract file.

(b) Develop the warranty using enclosure (3), form NAVAIR 13070/1, NAVAIR Warranty Application Checklist, and provide a completed checklist when processing the PR, and coordinate the warranty development with AIR-02 and AIR-00C.

(c) Assess the effectiveness of each warranty.

(d) Develop/establish a warranty implementation plan in coordination with the APML/LM, AIR-119/contract administration office/ACO, PCO, and the contractor.

(e) Coordinate the warranty with related initial/replenishment spare procuring agencies to ensure compatibility with future initial/replenishment spare procurements, ensure that requirements necessary to minimize the cost of implementing initial/replenishment spare warranties are addressed, and provide guidance with regard to the type and extent of program related initial/replenishment spare warranties. This effort will be accomplished in conjunction with AIR-412 and the APML/LM.

5. Forms. NAVAIR 13070/1, NAVAIR Warranty Application Checklist, is available from the NAVAIR Forms Stock Room.

6. Cancellation. The notice remains in effect until incorporated into a NAVAIR Instruction.

J. B. WILKINSON

Distribution: FKA1A (established quantity)
SNDL: FKA1A (Deputy Commander, NAVAIR Acquisition Executive and Deputy Commander for Operations, Assistant Commanders, Comptroller, Command Special Assistants, Program Directors, Designated Program Managers, Directorate Directors, and Office and Division Directors)

Copy to: (2 copies each unless otherwise indicated)
SNDL: C8E3 (Morgantown (1 copy)); FKA1A (AIR-7123Z (10 copies), AIR-712333 (40 copies), AIR-5162 (5 copies))

Stocked: NAVAIRHQ (AIR-712333)

LIST OF REFERENCES

Andrews, Melissa S. and Hickey, Christine, *Analysis of Navy Aircraft Engine and Engine Component Warranties*, Master's Thesis, Naval Postgraduate School, Monterey California, December 1993.

Balaban, Harold, *Warranty Handbook*, AIRINC, Defense Systems Management College, June 1986.

Fout, Robert, *Warranty Guidebook*, MKI, Defense Systems Management College, October 1992.

Interview between Balaban, Harold S. PhD, AIRINC and the author 22 February 1994.

Interview between Brooks, Teresa, Defense Systems Procurement Strategies, Office of the Under Secretary of Defense (Acquisition), and the author 24 March 1994.

Interview between Cleer, James P., Logistics Support Division Analyst, Naval Air Systems Command, (AIR-41111D), and the author 24 February 1994.

Interview between Eaton, Donald R., RADM USN(RET), Logistics Chair, Naval Postgraduate School and the author 16 March 1994.

Interview between Enter, George, Procurement Policy Division, Office of the Assistant Secretary of the Navy (Research Development and Acquisition), and the author 23 March 1994.

Interview between Fout, Robert, MKI, Dumphries, Virginia and the author 24 February 1994.

Interview between Grant, Susan J., Business Management Directorate, Office of the DoD Comptroller Propulsion ODC(MS)BMD and the author 25 February, 1994.

Interview between Pauling, Dave, Propulsion and Power Division Branch Head Engineer, Naval Air Systems Command, (AIR-5362), and the author 25 February, 1994.

Interview between Spector, Eleanor, Director of Defense Procurement, Office of the Under Secretary of Defense (Acquisition), and the author 24 March 1994.

Interview between Squire, Daniel E., Propulsion and Power Division Engineer, Naval Air Systems Command, (AIR-53612C),

and the author 23 February 1994.

Interview between Sylvester, Rick, Office of Acquisition Reform, Office of the Under Secretary of Defense (Acquisition), and the author 24 March 1994.

Interview between Townsend, Dianne, Legal Counsel, Naval Air Systems Command, (AIR-00C3), and the author 22 March 1994.

Kuenne, Robert E. and others, *Warranties in Weapon System Procurement: an Analysis of Practice and Theory*, Institute For Defense Analyses, IDA Paper P-2024.

Nelson J. R. and Balaban, Harold S., *Acquisition Strategy Guide*, AIRINC, Defense Systems Management College, June 1984.

Office of Management and Budget letter to Committee on Government Affairs, Subject, Mark-up of S.1587, 5 November 1993.

Office of the Deputy Director for Defense Systems Procurement Strategies, *Report on the Administration of Department of Defense Weapon System Warranties*, September 1992.

Telephone conversation between Brown, Calvin, Phd, Defense Systems Management College and the author 19 January 1994.

Telephone conversation between Choate, Steven, Cpt USMC, Naval Aviation Maintenance Office (NAMO 414-1) and the author 6 June 1994.

Telephone conversation between Field, Kevin, F414 Navy Program Integrator, General Electric Aircraft Engines, Lynn Massachusetts and the author 28 May 1994.

Telephone conversation between Fink, Dan, Director Logistics Review Group Program Director, Chief of Naval Operations (N432) and the author 6 June 1994.

Telephone conversation between Gayron, Mike, F404 Program Manager, General Electric Aircraft Engines, Lynn Massachusetts and the author 28 May 1994.

Telephone conversation between Guli, Sal, Program Director for Contract Audits, Office of the Inspector General of the Department of Defense and the author 28 April 1994.

Telephone conversation between Hu, Kang S, Cost Analyst Division Analyst (AIR-52431B) Naval Air Systems Command Warranty Program Manager, and the author 19 May 1994.

Telephone conversation between Jordan, Thomas, T700 Warranty Program Manager, General Electric Aircraft Engines, Lynn Massachusetts and the author 28 May 1994.

Telephone conversation between Matson, Karl, F110 Engine Program Manager, General Electric Aircraft Engines, and the author 6 June 1994.

Telephone conversation between Pressman, Allan, Cost Analyst Division Analyst (AIR-52431B) Naval Air Systems Command Warranty Program Manager, and the author 6 June 1994.

Telephone conversation between Sipple, Mike, Defense Systems Procurement Strategies, Office of the Under Secretary of Defense (Acquisition), and the author 6 February 1994.

Telephone conversation between Tourville, Bob, Manufacturing and Engineering Branch Head (AIR-516), Naval Air Systems Command Warranty Program Manager, and the author 19 January 1994.

U. S. Department of Defense. *Report of the Acquisition Law Advisory Panel, Streamlining Defense Acquisition Laws,* January 1993.

BIBLIOGRAPHY

Andrews, M. S., and Hickey, S. C. Analysis of Navy Aircraft Engine and Engine Component Warranties, Thesis 1993.33

Berke, Toby. M., and Zaino, Nicholas. A. Jr, Warranties: What are they? What do They Really Cost?. 1991 Proceedings Annual Reliability and Maintainability Symposium.

Fout, Robert. Warranty Guidebook, 2nd ed, Defense Systems Management College, Ft Belvoir VA 1992.

Gill, Leroy. Evaluating the Benefits and Costs of DOD Warranties. The Journal of Cost Analysis, Summer 1989, pp 55-72.

Henderson, David R. The Fortune Encyclopedia of Economics, Warner Books Inc., 1993.

Kuenne, Robert E. and others, Warranties in Weapon System Procurement: an Analysis of Practice and Theory, Institute for Defense, Alexandria Virginia, April 1987.

Office of the Deputy Director for Defense Systems Procurement Strategies. Report on the Administration of Department of Defense Weapon System Warranties. September 1992.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 52 Naval Postrgaduate School Monterey, California 93943-5101	2
3.	Director Defense Logistic Studies Information Exchange U. S. Army Logistics Management College Fort Lee, Virginia 23801-6043	1
4.	Assistant Commander for Logistics and Fleet Support Naval Air Systems Command Code 04 Washington, DC 20361-5360	1
5.	Assistant Commander for Engineering Naval Air Systems Command Code 05 Washington, DC 20361-5360	1
6.	Assistant Commander for Contracts Naval Air Systems Command Code 02 Washington, DC 20361-5360	1
7.	Director Propulsion and Power Division Naval Air Systems Command Code 536 Washington, DC 20361-5360	1
8.	Director Logistics and Maintenance Policy Division Naval Air Systems Command Code 411 Washington, DC 20361-5360	1
9.	Director Logistics Management Division Naval Air Systems Command Code 410 Washington, DC 20361-5360	1

10. Mr. Scott Cote', Code 6052 — 1
Naval Air Warfare Center
Propulsion Division
Warminster, Pennsylvania 18974-5000

11. Professor Alan W. McMasters, Code SM/MG — 2
Department of Systems Management
Naval Postgraduate School
Monterey, California 93943-5103

12. Professor David R. Henderson, Code SM/HT — 1
Department of Systems Management
Naval Postgraduate School
Monterey, California 93943-5103

13. CDR D. H. Genovese — 1
Carrier Group One
NAS North Island
San Diego, California 92135-5000

14. Assistant Chief of Naval Operations (Air Warfare) — 1
Head Aviation Programs Branch Code N881
Office of the Chief of Naval Operations
Washington, DC 20350-2000

15. Assistant Chief of Naval Operations (Logistics) — 1
Director Supportability, Maintenance and Modernization
Code N43
Office of the Chief of Naval Operations
Washington, DC 20350-2000

16. Under Secretary of Defense (Acquisition) — 1
Director of Defense Procurement
Office of the Secretary of Defense
Washington, DC 20350-2000

17. Under Secretary of Defense (Acquisition) — 1
Deputy Under Secretary of Defense Acquisition Reform
Office of the Secretary of Defense
Washington, DC 20350-2000

18. Assistant Secretary of the Navy — 1
(Research, Development and Acquisition)
Office of the Secretary of the Navy
Washington, DC 20350-1000